[COMMITTEE PRINT]

ENERGY-EFFICIENT TECHNOLOGY: ADVANCING U.S. COMPETITIVENESS AND PRODUCTIVITY

PROCEEDINGS OF A SEMINAR

REPORT

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October 26, 1982

LETTER OF TRANSMITTAL

To All Members of the Committee on Science and Technology:

I am herewith transmitting a report of the proceedings of a Seminar conducted by the Congressional Research Service for the Subcommittee on Energy Development and Applications entitled: "Energy Efficient Technology: Advancing U. S. Competitiveness and Productivity."

The report recounts the proceedings of the Seminar held on February 11, 1982 by the Congressional Research Service on the Department of Energy's Industrial Conservation Program. The purpose of the seminar was to examine the impacts of the budget reductions and the Administration's proposal to terminate this program area.

The Seminar included three panels of distinguished speakers representing major corporate interests, energy consultants, public interest groups, and the Federal Government. A panel on Industrial Process Efficiency examined issues related to the effects of Federal incentives and energy prices on the use of more efficient equipment for industrial processes. A second panel on Energy Conversion Equipment examined issues related to the effects of Federal incentives and energy prices on the manufacture of more efficient energy conversion equipment. The final panel on Policies and Programs examined issues related to the appropriateness of Federal programs and incentives for the development of the energy conservation industry in light of increasing efforts by Japanese and European programs to penetrate U.S. and International markets for energy efficient equipment.

Because these issues remain topical, this report was requested for our use in further deliberations and to aid us in our decisionmaking process on matters relating to the future of the DOE's industrial energy conservation program.

Sincerely,

DON FUQUA
Chairman

Congressional Research Service
The Library of Congress

Washington, D.C. 20540

LETTER OF SUBMITTAL

October 22, 1982

Honorable Don Fuqua
Chairman, Subcommittee on Energy Development
and Applications
Committee on Science and Technology
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

I am pleased to forward these proceedings of the CRS seminar on "Energy Efficient Technology: Advancing U.S. Competitiveness and Productivity" held February 11, 1982, which have been transcribed at your request.

The subjects related to the improvement of energy use efficiency in industry and to the production of technologies which are more energy-efficient are important in a broad range of national energy conservation issues. I am pleased that the Committee on Science and Technology has seen fit to expand the audience of the CRS seminar on this important topic through publication of the proceedings.

The seminar included three panels. The first panel addressed issues involving private sector activity, Federal incentives and international markets related to industrial process efficiency. The second focused on similar types of issues related to the production and use of more efficient energy conversion equipment. The final panel underscored the role of Federal policy and programs in these two areas.

The seminar was moderated by Dr. Langdon Crane and Mr. Fred Sissine of the Science Policy Research Division, who also edited the transcripts of the proceedings.

Sincerely,

Gilbert Gude
Director

ENERGY-EFFICIENT TECHNOLOGY:
ADVANCING U.S. COMPETITIVENESS AND PRODUCTIVITY

Langton T. Crane
Specialist in Science and Technology
Science Policy Research Division
Moderator, Editor

Fred Sissine
Analyst in Energy Technology
Science Policy Research Division
Moderator, Editor

February 1982

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ENERGY-EFFICIENT TECHNOLOGY: ADVANCING U.S. COMPETITIVENESS AND PRODUCTIVITY

Proceedings of a Seminar

THURSDAY, FEBRUARY 11, 1982

The members of the seminar met at 9 a.m., in the Whittall Pavilion, Library of Congress Building, Washington, D.C.

Present: Gilbert Gude, Director, Congressional Research Service; Langdon T. Crane, Specialist, Science and Technology, CRS; and Fred J. Sissine, Analyst, Energy Technology, CRS.

GILBERT GUDE, DIRECTOR, CRS

Mr. Gude. Shall we come to order?

I would like to bid you a good morning. I am Gilbert Gude, Director of the Congressional Research Service. I wanted to welcome you to what we term the neutral ambience of the Whittall Pavilion. We generally work to shed more light than heat on subjects here, to assist our clients in the congressional community.

I want to thank Langdon Crane and Fred Sissine of the Science Policy Research Division who worked to put together today's exercises. As you know, we are having these recorded, and they should subsequently be part of a committee print.

Our moderator and major-domo of this exercise is Langdon Crane, a specialist in our Science Policy Research Division. Langdon attended both Amherst and Brown, received his doctorate in physics at the University of Maryland, has done research in the private sector with the Ford Motor Co., and also was a program director for some years at the National Science Foundation.

Our other moderator is Fred Sissine, an analyst in the Science Policy Research Division. Fred received a degree in physics at the California State University in Northridge, Calif. He has done research on the social aspects of genetic counseling for Children's Hospital of Pittsburgh, and is currently a candidate for a doctorate in public policy at the University of Pittsburgh.

Langdon has been a member of the Congressional Research Service since 1975, and Fred has been with CRS since 1980. Gentlemen, thank you for your work on today's program.

DR. LANGDON T. CRANE, SPECIALIST, CRS

Dr. Crane. Today, we are discussing industrial energy conservation. Our particular focus of attention is what can be done to insure the rapid development and adoption of energy-efficient technology in order to assure the optimum competitiveness and productivity of American industry.

We have three distinguished panels that will be addressing this topic today: the first on energy process efficiency; the second on energy conservation equipment; and finally, this afternoon, the third panel will focus on Federal policies and programs. However, we expect that consideration of policies and programs will be threaded through all of the discussion today.

Each speaker will be allowd up to 15 minutes to present briefly his views, describe the problems that his particular company or industry are facing, and to comment on what might be done to insure rapid adoption of energy conserving technologies through the coming years.

At this point, I would like to turn the program over to my colleague, Fred Sissine, who will be moderating the first panel.

FRED J. SISSINE, ANALYST, CRS

Mr. SISSINE. We are honored to have with us this morning a very distinguished group of gentlemen on this, our lead-off panel.

This panel includes Douglas Harvey, Philip Huyck, Roy Leidner, and Allen Sheldon.

INDUSTRIAL PROCESS EFFICIENCY

STATEMENTS OF DOUGLAS G. HARVEY, INDUSTRIAL ENERGY CONSULTANT, BALTIMORE, MD.; PHILIP M. HYUCK, VICE PRESIDENT, THE FIRST BOSTON CORP., NEW YORK, N.Y.; ROY N. LEIDNER, DIRECTOR OF CORPORATE ENERGY AFFAIRS, BETHLEHEM STEEL CORP., BETHLEHEM, PA.; AND ALLEN C. SHELDON, VICE PRESIDENT OF ENERGY RESOURCES, ALUMINUM CO. OF AMERICA, PITTSBURGH, PA.

Mr. SISSINE. Each panelist will describe what he sees as particularly important developments in the area of industrial process efficiency.

He will also characterize what role, if any, the Federal Government should play in this area. I will ask the audience to reserve their questions until after the entire panel is finished unless it requires a point that demands immediate clarification.

Our first speaker will be Doug Harvey. Doug's training was primarily in chemistry. He has spent many years with the private sector, and has been especially involved with the engineering of space power systems. Doug spent 6 years with the Federal Government, which he culminated as head of the Department of Energy [DOE] industrial energy conservation program. He is now working as an independent consultant.

Doug?

[A biographical sketch of Mr. Harvey follows:]

ABOUT THE AUTHOR

In the spring of 1975, Mr. Harvey, as a consultant, was asked by the Energy Research and Development Administration (ERDA) to develop the Industrial Conservation program. Mr. Harvey joined the staff of the ERDA in August 1975 on a full-time basis as Assistant Director of the Division of Buildings and Industry. He came to this position after twenty-three years of industrial experience. Seventeen of those years were devoted to space power systems with Martin Marietta Corporation and Sanders Associates, Inc. During this period he gained extensive insight into the materials and engineering aspects of metals, ceramics, plastics and other basic structural materials. More recently, as Vice President, Energy and Environmental Systems of Hittman Associates, Inc., Mr. Harvey gained significant experience in the problems of balancing energy consumption with environmental quality. He is the author of two books: Radioisotope Power Generation; and, The Automobile; Energy and the Environment. He is a graduate of Trinity College (1952) with a BS in chemistry, and MIT (1953) with an MS in nuclear chemistry. In June of 1976, the Division of Industrial Energy Conservation was established as a separate operating entity and Mr. Harvey was appointed Director of that Division. With the formation of the Department of Energy (DOE), the responsibilities of the Office of Industrial Programs was expanded to incorporate the industrial reporting efforts of Federal Energy Administration and the business awareness program of the Department of Commerce. Mr. Harvey was named Director of that Office in January 1979. He resigned from DOE in January 1981 but was requested to remain until most of the transition was completed. On April 17 he left DOE to become a consultant to the private sector.

STATEMENT OF DOUGLAS G. HARVEY*

Mr. HARVEY. There can be no argument with the premise that it is in the national interest to improve the efficiency of energy use throughout the industrial sector.

A perception that increasing energy use efficiency is exactly equivalent to increasing energy supply is really as valid today as it was when Congress passed the Non-Nuclear Energy Act of 1974. What is at issue is how much do we want to improve energy efficiency throughout the industrial sector, how soon do we want to achieve it, and what are the most cost-effective means of achieving those goals?

There are really three levels of energy productivity that one can consider: the current level, the amount of energy that is consumed per unit of product using today's technology; the level of energy savings that could be achieved using best-available technology; and the level of improvement in energy productivity that may be possible by using new, unproven, and innovative technology.

It has been estimated, using 1972 as a base, that the industrial sector can improve their energy use efficiency by 20 to 23 percent using retrofit best-available technology in existing plant and equipment.

If industry were to completely replace plant and equipment with the most modern, best-available technology, the efficiency improvements could be as high as 30 percent.

With new processes that have been identified and are currently emerging, that efficiency could perhaps be improved up to 50 percent. That is, 50 percent less energy would be consumed to produce the same amount of product that is produced currently in the industrial sector.

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*Deceased.

These are the sorts of targets we are talking about.

When Congress passed Public Law 93-577, the Federal Non-Nuclear Energy Research and Development Act, and chartered the Energy Research and Development Agency [ERDA] with responsibility for conducting a cooperative R&D program with industry, its intent was to achieve the 50 percent level of energy savings with new process technology.

The current administration has taken issue with this stance. Its position is expressed clearly in the National Energy Policy Plan. The plan states that—

> Motivated by rising energy prices, individuals, businesses, and other institutions are undertaking serious efforts to modify energy use patterns of the recent past.

The passage of the Economic Recovery Tax Act, with its provisions for more rapid depreciation, investment tax credits and research tax credits—coupled with rising energy prices—are perceived by this administration to provide all of the motivation required to improve industrial energy productivity.

This is the basic dichotomy that exists within the Federal Government today. On one hand, there is the perception that a participatory role by the Federal Government is needed to achieve improved efficiency through the introduction of advanced processes. On the other hand, there is the administration's view that this can be achieved simply by the free market mechanism, itself.

I would like to examine quantitatively the impact of these two positions, and to do this, you have to understand a little bit about how industry makes a determination on whether or not to invest capital.

There are two types of capital moneys that industry invests. One is nondiscretionary, and the other is discretionary.

The nondiscretionary investments are those which are required in order to stay in business.

These investments include such things as conformance with Environmental Protection Agency and Occupational Safety and Health Administration regulations. They also include the replacement of plant and equipment that is worn or failed during the course of a given year. An example of this investment category would include the replacement of rollers in a rolling mill of the steel industry.

These are clearly investments that are required absolutely in order to continue the return on investment of the sunk capital in the plant and equipment.

Inasmuch as they do not, themselves, increase productivity, they have no real net increase in return on investment.

However, they have a return on investment in the sense that they allow the sunk investment to continue to provide its relative return.

Discretionary investments are of a different nature. They are judgmental. The board of directors can make a judgment as to whether or not to make such investments. These investments could include the purchase of best-available technology. For example, one such investment would be the purchase of a condensate return system which improves productivity and has a net return on investment. Most of the best-available technology investments have no risks whatsoever associated with them: they are proven technologies which have been used before.

The category of discretionary investments also includes the development of a new product. Here the corporation is making an investment primarily to capture a greater market share for their products, and investment in new products are continuously evaluated by corporate boards.

The third type of discretionary investment is in new process development. Clearly, the research, development, and demonstration of a new process in the industrial sector involves considerable risk. For this reason, it is the least likely type of a discretionary investment to be made.

This point is made quite clearly in a paper by Myers and Sweezly called "Why Innovations Fail." It estimates that new process technologies which have not gone through prototype and full demonstration have a 60-percent probability of failure.

The plant manager that has to interpose a new process step in his process stream is very reluctant to do so—with very good reason. He may be rewarded for improving the productivity of that process stream, but if the whole process stream should be shut down due to the failure of an unproven technology, the manager is fired.

The plant shutdown is a catastrophic stoppage that prevents the return of investment on the entire plant.

Let me review some of the new processes that have been introduced into some of our basic industries. I am not talking about things like biogenetics or computer technology, where indeed a great deal of research is done. I am talking about steel, aluminum, copper, pulp and paper, textile, cement, and glass industries.

In the steel industry I looked at the number of innovations that have been introduced over a number of past years. In hot metal production, the large blast furnace was introduced by Japan in 1967. The bell-less blast furnace top was developed by Luxembourg in 1972; the movable throat armor by Germany and Japan in 1969. In steel-making itself, the basic oxygen furnace [BOF] was introduced by Germany in 1955.

A new BOF process known as the Max Hutte process, was recently developed by Germany. This process allows a very much greater concentration of scrap to be melted in a basic oxygen furnace. Up to 40 to 50 percent scrap can be used in a basic oxygen furnace so equipped. Continuous casting was introduced by Belgium. The new dual-phase annealing process developed by the Japanese, which permits annealing steel coil in 10 minutes versus 10 days for the standard batch annealing process, was introduced by Japan in 1980.

Really, there are only two major innovations that have come from the United States—and both have been partially funded by the Department of Energy. One is hot inspection of continuously cast slabs. The other is the ceramic recuperator, which has great applicability to reheat furnaces.

In the aluminum industry's energy conservation workshop held on November 8 last year, 7 out of 17 technical papers that were presented had to do with programs developed jointly by the Department of Energy and the private sector.

In the textile industry, the only new developments have been those which have been jointly funded by DOE and the private sector. Foam finishing, dying and printing in the textile industry has saved up to 86 percent of the thermal energy required for those processes. I am looking at, for one of my clients, the application of this same technology to gravure printing of paper.

Hyperfiltration was developed for separating the dyestuffs from the water used in the Beck dying process. This process was developed jointly by Clemson University and the Department of Energy, and is now entering the textile marketplace. This technology also seems to have very significant application in the food industry. We are now concentrating tomato juice with hyperfiltration instead of heat.

So, these are the types of programs we are discussing, the discretionary investments supported by DOE.

The question remains, would the private sector undertake these investments by themselves? I have analyzed this subject, and I am submitting for the record a copy of a paper that describes this analysis in detail. The following remarks relate to that paper.

One of the problems with simply allowing the Economic Recovery Tax Act to promote investment in existing best-available technology is the discount rate. This subject was analyzed for some of our basic industries.

The long-term bond yield in January 1981, is given for these industries and then the yield for September 1981.

The implied increase and the discount rate over that period of time is a factor of 2 points, that is, if a corporate discount rate was 14 percent in January, it probably is 16 percent today.

At this point, I should mention something about hurdle rates. After nondiscretionary capital is taken out of the capital pool, the remaining capital has to generate a return on investment somewhat greater than the discount rate. A 10-point differential is generally the rule-of-thumb.

Assuming a hurdle rate for discretionary investments of 10 points over the discount rate, a $1,000 investment—before enactment of the Economic Recovery Tax Act—would have to return $580 to be a viable discretionary investment.

After the passage of ERTA, the required return would be about $480. A two point increase in the discount rate, however, would increase the required return to about $535. Thus, the advantageous impact of ERTA on the ability of industry to invest in best-available technology would be cut in half.

When it comes to high risk technology, different criteria have to be used. A company investing in RD&D on a new process must receive a higher return on investment to allow for the risk of failure. The ratio of the risk adjusted internal rate of return to the hurdle rate of return is inversely proportional to the probability of success raised to an exponent X. When X equals one, no special premium is placed on risk, and the company is very willing to accept risk. One can plot this relationship to establish the "indifference curve" for a company willing to accept risk. Any project falling above this curve would probably be undertaken by such a company. If the probability of success were 50 percent the risk adjusted return must be twice the hurdle rate.

This means, that if you have 10 products with a 50-percent probability of failure, 5 of them will fail. Furthermore, the corporation must receive twice as much out of the five that do succeed.

What does this mean in terms of new technology?

Well, I looked——

Mr. SHEAHEN. One over one minus P?

Mr. HARVEY. X is essentially the willingness of a corporation to accept risk.

When X equals one, there is no premium placed on risk. When X is greater than one, it says a corporation is very unwilling to accept risk—like a products corporation would place an exponential value greater than one to allow for the probability of failure. When X equals one, the company has to be very willing to accept risk.

In order to estimate the strength of Federal policy to motivate industry to perform RD&D, four specific projects that are currently underway in the Department of Energy were evaluated. I calculated the probability of failure, for diesel cogeneration, a high efficiency ceramic recuperator, an electric Rankine heat pump, and a high effectiveness metallic recuperator. The probabilities of failure range from 15 to 70 percent for these four projects.

I did a detailed return on investment analysis to the developer and compared that to the X equals one indifference curve.

The strength of the 25-percent investment tax credit given for research and development under the Economic Recovery Tax Act for these four projects does not even come close to raising the return on investment above the indifference curve. The only Federal option that does is the incentive provided through cost shared R&D.

I then examined the cost effectiveness of such Federal investments, and compared this with the Federal investment in oil depletion.

First of all, the return of investment, based on 20 percent of the profits that are occasioned by the increased productivity with the using companies, not the developing companies, are returned to the Federal Government.

The risk adjusted internal rate of return on investment to the Federal Government is 38 percent. I compared this with the rate of return resulting from the depletion allowance on oil production. This turned out to be 28 percent. Thus, the Federal investment in cost shared R&D for improving energy productivity is at least 10 points better than the Federal subsidy of new oil production.

I guess that about summarizes everything.

Dr. FRANKEL. Gene Frankel.

On the previous chart, you were saying that the Economic Recovery Tax Act program could not bring the return on investment up to the indifference curve, but that cost-sharing does bring you up to the indifference curve for very risk-willing companies?

Mr. HARVEY. Very risk-willing companies.

Dr. FRANKEL. A is the Economic Recovery Tax Act, and B is the cost-sharing?

Mr. HARVEY. I see that I'm running out of time, so I should point out that your question can be answered by referring to a paper that I prepared on this subject which will be provided for the record.

Mr. SISSINE. Thank you, Doug.

[The paper mentioned above follows:]

9

AN ASSESSMENT OF THE FEDERAL ROLE IN INDUSTRIAL ENERGY PRODUCTIVITY

Douglas G. Harvey
Industrial Energy Consultant

Abstract

There is a continuing debate on the proper role of the Federal Government in assisting industry to achieve more efficient use of energy. The Administration asserts that the National Recovery Tax Act provides the necessary incentives to improve industrial productivity. Many congressional leaders feel that a more participating role such as cost-shared contracts, as currently practiced by DOE, are necessary and essential functions if energy productivity is to be significantly improved. This paper quantitatively examines this issue and establishes the strength of these (and one other) Federal options to motivate industry to improve energy productivity through: 1) an increased use of "best available" technology; and 2) developing new high risk technology. The following conclusions are drawn:

1. *The incentives offered by the Economic Recovery Tax Act will provide industry with some incentive to increase the rate at which best available technology is introduced. The increased rate ranges between 3 and 20 percent depending on the discount rate.*

2. *The interest rate is a far more important factor than the Tax Act itself in determining the rate at which best available technology is introduced.*

3. *In the absence of direct Federal cost sharing in RD&D projects there are no incentives enacted or contemplated which would significantly accelerate RD&D in high risk new technology to improve energy productivity.*

4. *The cost effectiveness to the Federal government of cost shared RD&D is extremely high, averaging a 30% return per year on all monies invested after discounting for risk.*

5. *The Federal government's unique ability to tax a corporation's increased profits occasioned by increased energy productivity, makes it the only party involved that can reap such benefits.*

6. *The objectives regarding new technology development, mandated by Congress in the Non-nuclear Act of 1974 will not be met unless an active, participating Federal role is continued.*

INTRODUCTION

There can be no argument with the premise that it is in the national interest to improve the efficiency with which energy is consumed in our industry. The perception that increasing energy use efficiency is equivalent to increasing energy supply and in most cases is a faster and less costly avenue of pursuit, is as accurate today as it was when Congress passed the Non-Nuclear Energy Act in 1974. What is at issue is how much improvement in efficiency do we want, how soon do we want to achieve this level of improvement, and what are the most cost effective alternatives to accomplish these goals?

Three levels of industrial energy productivity should be considered; the current level of energy consumption per unit of product (UOP), the energy consumption per UOP using "best available technology," and the potential energy consumption per UOP using "advanced unproven technology." Using 1972 as a base year, it has been estimated that the industrial sector could save up to 22% of their energy consumption through the use of available retrofit technology; 23-28% through the total replacement of plant and equipment with the best available technology and up to 40-50% through the development and installation of new innovative technologies. These are the targets to be weighed in considering the proper Federal role.

In 1974 the Congress, under the Ford Administration, passed P.L. 93-577, Federal Non-Nuclear Energy Research and Development Act, which required the Energy Research and Development Agency (now DOE) to "...Formulate and carry out a comprehensive non-nuclear energy research, development and demonstration program." "...By initiating..programs..utilizing facilities, capabilities, expertise and experience of...industrial entities..which are appropriate..". This and later legislation (P.L. 94-163 Energy Policy and Conservation Act; P.L. 95-91 Department of Energy Organization Act; P.L. 96-294 Energy Security Act) firmly established the intent of Congress to achieve a level of industrial productivity approaching the 40 to 50% improvement possible through the use of advanced but high risk technology through direct Federal assistance.

The Reagan Administration has challenged this role. As expressed in the National Energy Policy Plan (ref. 1) "Motivated by rising energy prices, individuals, businesses, and other institutions are undertaking serious efforts to modify energy-use patterns of the recent past." The passage of the Energy Recovery Tax Act with its more rapid depreciation, investment tax credits, and research tax credits, coupled with rising energy prices are perceived by this administration to provide all of the motivation required to improve industrial energy productivity.

The analysis presented herein provides insight into the validity of these opposing positions, by examining the strength of the motivating force to induce industry to invest in both "best available" technology, and high risk new technology development.

Background

It is inaccurate to assume that all industry will react in the same way to Federal policy and tax legislation. The industrial sector consists of 20 major two-digit Standard Industrial Classification (SIC) codes and some 400,000 individual corporations. Each individual corporation has economic criteria by which it judges the relative merit of alternative opportunities for capital investment and for advanced technology development expenditures. For every corporation, there are three primary inputs which determine the cost of production: labor, capital, and materials (which include energy and feedstock). As the price of any of these goes up, one or more of the others will be substituted. For example, with increasing labor costs, there has been a significant movement toward the capital investment in automation and robotics (in this case, a substitution of capital for labor). Likewise, it can be anticipated that as the cost of energy increases, industry will in general respond by substituting capital for energy.

The role of energy in a corporation's production costs varies widely among different industries and is primarily associated with the energy intensity of the specific industry. An indication of the importance of energy costs to production costs was presented in the September 14, 1981 issue of Energy Users News (Ref. 2) and is summarized in Table 1 (Cement is not included but probably falls in the Glass, Brick category). Although the energy intensive industries (i.e., those above the industry average line) are especially sensitive to increasing energy costs, clearly, any industry of low profit margin (clothing, leather, etc.) is concerned about erosion of that margin through unnecessary production (energy) costs.

Table 1.

Energy Expenditures as a Percent of Pretax Profits

	1966	1976
Primary Metals	59.0%	217.6%
Glass, Brick	76.6	113.5
Paper	45.1	82.5
Textiles	31.0	70.1
Rubber, Plastics	24.5	69.1
Chemicals	27.4	62.6
Food	21.2	30.4
INDUSTRY AVERAGE	19.1	37.6
Furniture	14.0	27.07
Wood Products	29.4	26.6
Metal Products	14.2	25.1
Elec., Electronics	9.7	21.9
Clothing	12.5	17.3
Petroleum, Coal	11.8	16.7
Miscellaneous	21.9	15.2
Non-electric Machinery	8.2	14.7
Motor Vehicles	7.2	14.3
Leather	12.4	14.2
Instruments	3.9	11.9
Publications	7.2	10.6
Cigarettes	2.1	4.0

What factors influence a corporation to invest capital to decrease energy costs (increase energy productivity)? Although the answer to this question is very complex, three major parameters can be cited:

(1) The energy intensity -- as shown in Table 1, the steel, aluminum, copper, cement, glass, brick, paper, textile, rubber, plastic, chemical and food industries should have strong incentive to invest capital to decrease energy consumption (if this were the only factor involved).

(2) The capital intensity -- The required capital investment for production, is also a critical factor in evaluating willingness to make a discretionary energy conservation investment. The higher the capital intensity, in general, the less likely that money will be available for major discretionary investments. Unfortunately, those industries that are energy intensive are also capital intensive, which reduces their ability to invest in energy conservation _per se_.

(3) The availability and cost of capital -- capital for investment may be obtained from several sources; the sinking fund for replacement of depreciating property is generally the lowest cost source of capital; second is a portion of the profits not distributed to the stockholders; third is long-term bond issuance; and finally, borrowing at prime rate (or more).

Each corporation has a calculated composite discount rate (rd), which combines the ratio of capital obtained from each source. This discount rate is dependent on the corporation's current debt/equity ratio (often restricted in by-laws) in relation to other corporations in the same industry. Thus it is difficult to obtain quantitative information regarding r_d for any industry. Probably the best estimate for a composite r_d can be obtained by the current long-term bond yield and cost. Several composite values for energy intensive industries for January 1981 (Before Tax Act) and September 1981 (After Tax Act) are shown in Table 2.

Every corporation in the United States must expend capital each year just to stay in business. These expenditures are either non-discretionary or discretionary investments. Non-discretionary investments are those required to enable continued operation of the plant. As such they permit the return on the sunk capital in the plant to continue, but they do not usually improve the productivity of the process stream. Thus they do not provide a net increase in return on investment. Several examples of a non-discretionary investment include:

o Pollution control and safety equipment -- government regulations require that corporations comply with the mandates of EPA and OSHA legislation. The equivalent rate of return (ROR) on such equipment is usually negative since the equipment does not contribute to production but still requires operating and maintenance expense.

TABLE 2. COMPOSITE VALUE OF YIELDS ON LONG-TERM DEBENTURES FOR SELECTED INDUSTRIES

Industry	January 1981 Yield	Sept/Oct 1981 Yield	Implied Increase in r_d
Steel	13.45	15.08	1.63
Textiles	9.93	11.67	1.74
Rubber	14.51	16.75	2.25
Chemicals	13.02	15.25	2.23
Paper	10.23	13.04	2.81
Aluminum	11.53	14.05	2.52
		Implied average increase in r_d	2.20

Source: Wall Street Journal

Yield calculated for each bond issue in group based on interest on current price plus ballon payment at maturity. However, yield for each industry based on multiple bond issues in group.

- Replacement of worn or failed parts -- (e.g., new rolls in a rolling mill) the ROR on such equipment is essentially zero, since the entire process stream could not continue to operate unless replacement is accomplished, but its replacement does not involve an increase in production efficiency.

- Replacement of entire major process equipment (e.g., new boiler). Often a corporation, in replacing a large piece of equipment, can achieve a positive ROR since the new equipment is often more efficient than the old.

Discretionary capital expenditures are those over which corporate management can exercise judgemental decision. All such expenditures must have a positive ROR if management is properly exercising its mandate. Examples include:

- Proven process improvement technologies -- (e.g., continuous caster in steel; flying shuttle in weaving textiles, recuperator on forge furnace, condensate return on boiler, etc.). Such expenditures are not required to continue production but increase the efficiency of production such that operating costs are decreased. It is expenditures of this type that permit a corporation to advance from "current technology" towards "best available" technology. It is important to note that no risk of failure is involved in such expenditures.

- New Product Development and Introduction (e.g., Biogenetic introduction of Interferon, microchips, bubble memory, etc.). In this case, the corporation has expended research and development money to prove the viability of production and then makes the decision to invest capital in production machinery. The motivation is the perceived expansion of product lines and increase in market share. Risk is involved in such a decision since the acceptability of the new product in the marketplace is questionable.

- New Process Development and Introduction -- discretionary investment in a new unproven process step designed primarily to improve production efficiency is the least likely type of investment to be made. There are several reasons for this statement:

  - The risk is high. Myers and Sweezy in documenting "Why Innovations Fail" (Ref. 3) state that technologies that have not been proven in pilot or full-scale demonstration have a 65 percent chance of failure (failure being defined as not achieving economic or technical viability).

  - The plant manager is very reluctant to interpose unproven equipment in a process stream if failure could mean loss of production.

- The ability of a corporation to protect its proprietary position in process improvements is severely limited. Competitors learning of the general approach can usually reproduce such improvements (with modification) without violating patent or secrecy provisions. Thus there is little advantage to the developing corporation in terms of improved market share, and only short-term advantage in terms of improved productivity. Generally the attitude of "It's not bad to be second or third" prevails in the manufacturing process industry.

A corporation planning a capital investment plan for the year must balance the non-discretionary investments with the discretionary investments such that the overall rate of return (ROR) equals the corporation's discount rate (r_d). This is shown in the following simplified example:

> A corporation has decided to invest $1,000 in capital equipment. Its discount rate is 15 percent. Non-discretionary investments required to stay in business total $400 — they yield no net increase in ROR. The remaining $600 investment capital must yield an increased return of 25 percent or $150 to allow the total return to equal the discount rate on the total $1,000 capital pool. The 25 percent ROR required on discretionary investment is often called the "hurdle rate." Any candidate project whose projected ROR equals or exceeds this hurdle rate is an eligible candidate for investment funds.

A corporation will normally develop a list of those candidate discretionary projects (i.e., in order of decreasing anticipated ROR) and establish a cut-off when the cumulative cost equals the available discretionary funds (i.e., $600 in the example presented).

When non-discretionary investment requirements are high the hurdle rate for discretionary ROR increases significantly.

As interest rates increase, r_d for any given corporation, increases: likewise the hurdle rate must increase. Thus an investment yielding a 25 percent ROR six months ago when the r_d was 15 percent would not be a viable investment today if r_d had risen to 18 percent. Accordingly, the difference ($ROR-r_d$) is a key parameter in evaluating alternative Federal incentives for motivating investments to improve energy efficiency.

THE IMPACT OF THE ECONOMIC RECOVERY TAX ACT ON INDUSTRIAL INVESTMENT IN BEST AVAILABLE TECHNOLOGY

With this background in mind it is possible to evaluate the strength of the ERTA in motivating industry to invest in proven (low risk) best available technology.

The equation and calculations shown in Table 3 were used to evaluate the ROR parametrically as a function of the discount rate, and the net dollar return on the investment for investments made prior to the passage

Table 3

Calculation of Equivalent rate of Return (ROR) for Energy Related Capital Investments

The equation

$$ROR = e^{\frac{\ln \frac{Y}{C\,(1-b)}}{n}} -1$$

is used in calculating ROR where:

$$Y = \sum_{i=o}^{i=n-1} \left\{C_e(1+r_e)^i\ (1+r_d)^{n-1-i}\ (1-T)\right\} + \sum_{i=o}^{i=m-1} \left\{\frac{C}{M}\ (T(1+r_d)^{n-1-i}\right\}$$

ROR = The equivalent rate of return on the investment as if the dollars returned were invested at the discount rate compounded annually over the life of the equipment.

C = the capital required for the investment.

C_e = The annual net dollar return on the investment.

r_e = The average rate at which the cost of energy is anticipated to increase per year over the life of the investment (fraction).

r_d = The discount rate for the corporation (fraction)

n = The useful life of the investment (years).

T = The tax rate of the corporation (faction).

b = Investment tax credit (fraction).

m = The allowable depreciation period (years) (assumes straight line depreciation).

NOTE: ROR differs from the more conventional internal rate of return (IRR) in that the latter assumes the income is invested at the same rate as yielded by this investment analyzed. ROR provides a more meaningful, figure of merit for each individual investment opportunity, since it assumes the income is invested at r_d (the discount rate).

of the Economic Recovery Tax Act and after passage of this act. The results are shown in Figures 1 and 2. In all cases the following inputs were held constant:

C = Capital invested = \$1,000

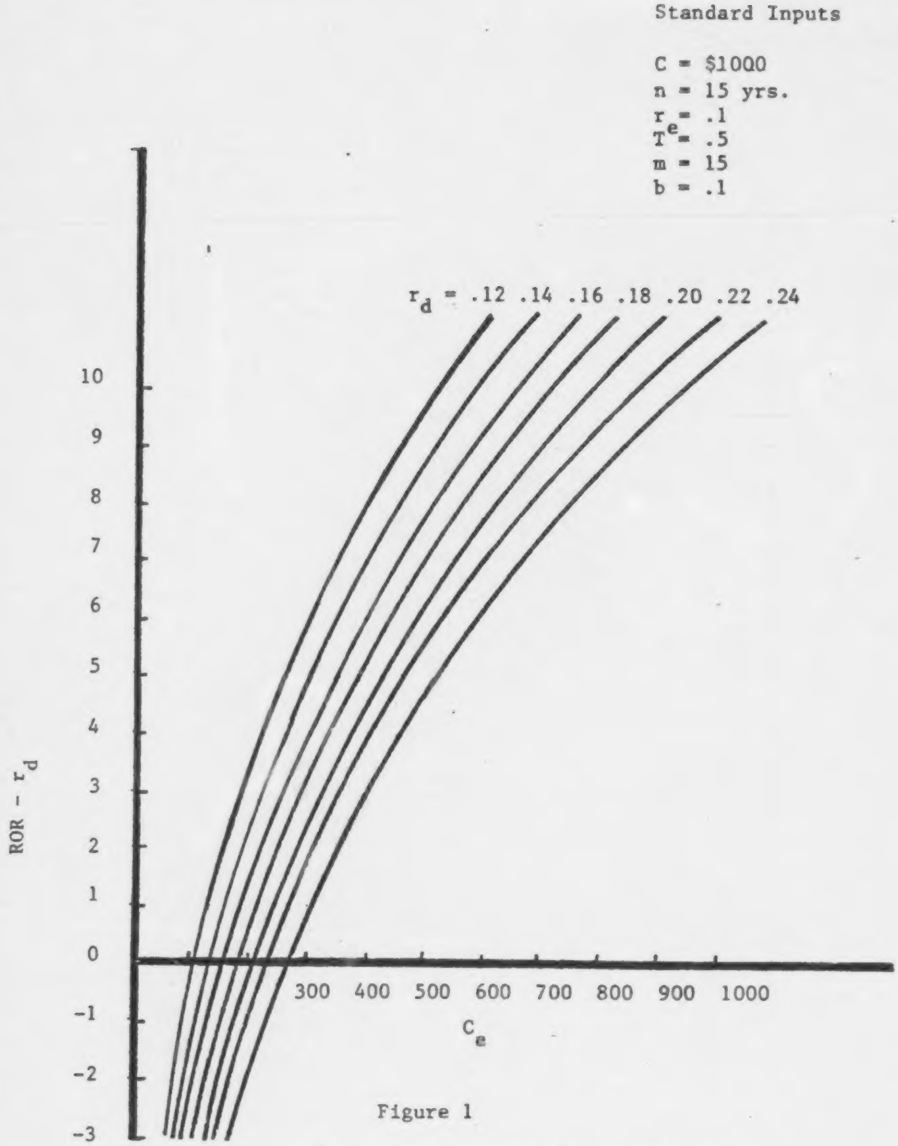
n = Useful life = 15 years

r_e = rate of energy cost increase per year = 0.1

T = corporate tax rate = .46

b = investment tax credit

m = depreciation life allowable



Standard Inputs

$C = \$1000$
$n = 15$ yrs.
$r_e = .1$
$T = .5$
$m = 15$
$b = .1$

Figure 1

Investment Return Prior to Tax Act

Standard Inputs

$C = \$1000$
$n = 15$ yrs.
$r_e = .1$
$T = .5$
$m = 5$
$b = .2$

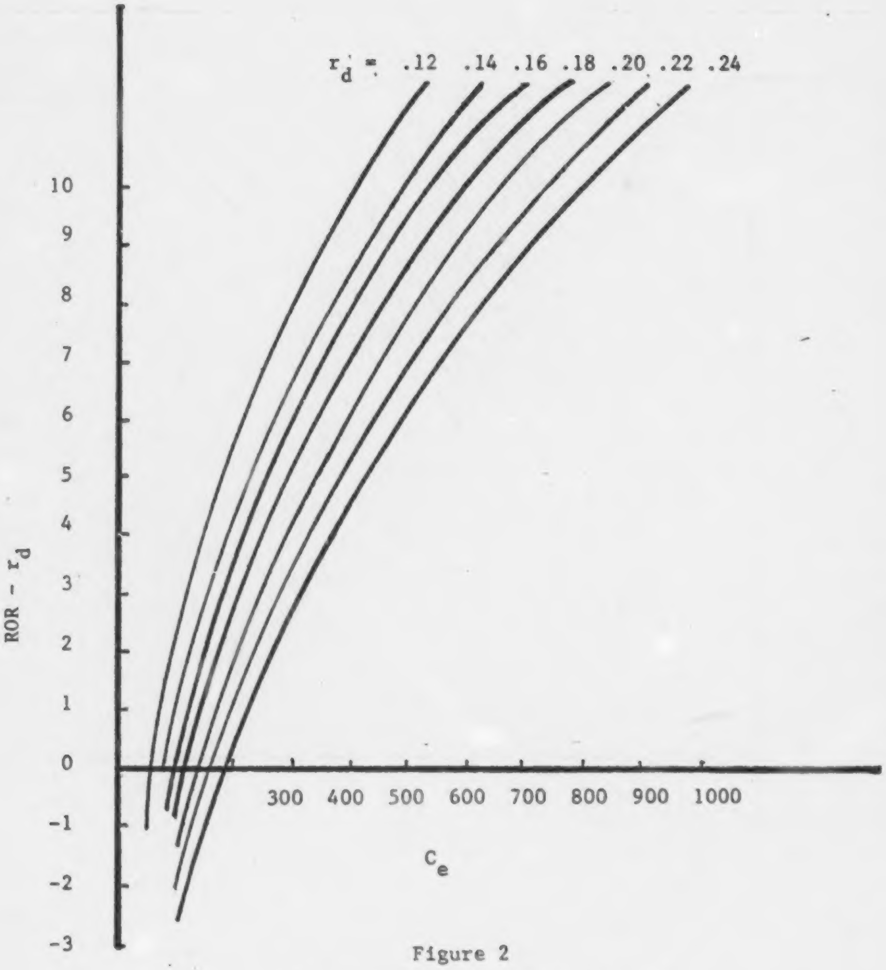


Figure 2

Investment Return After Tax Act

For the "before" Tax Act case the investment tax credit was taken as 0.1 (10%) and the depreciation life as 15 years. For the "after" Tax Act case the investment tax credit was taken as 0.2 (20%) and the depreciation life as five years.

If the hurdle rate is 10 points over the discount rate (ROR - r_d = 10), Figure 3 plots the required dollar return on a $1,000 investment as a function of the discount rate for both cases. Analysis of this figure provides insight into the strength of the Tax Act in motivating corporations to make investment in energy savings equipment. A corporation whose discount rate was 14 percent last January would have to return $580 (point 1) per year on a $1,000 investment to achieve the required hurdle rate. Today, after the Tax Act, (assuming r_d had not increased) the same hurdle rate could be achieved with $480 annual return (point 2). If, however, the discount rate had increased to 16 percent, a $535 annual return on the investment would be required (point 3). Thus an increase in interest rate (as reflected in the discount rate) of 2 points cuts the Administration's enacted tax advantages in half. It is this factor which has been instrumental in slowing industry's response to the Tax Act. Even the perception of future increases in interest rates causes the industrial sector to "wait and see".

This discussion has been hypothetical up to this point. It is possible, however, to lend credence to the derived data by examining a specific point. In January 1981 a spokesman of Union Carbide Corporation (ref. 4) stated that his company was willing to invest $18,000 capital to save one barrel of oil equivalent per day. Using an average contract price

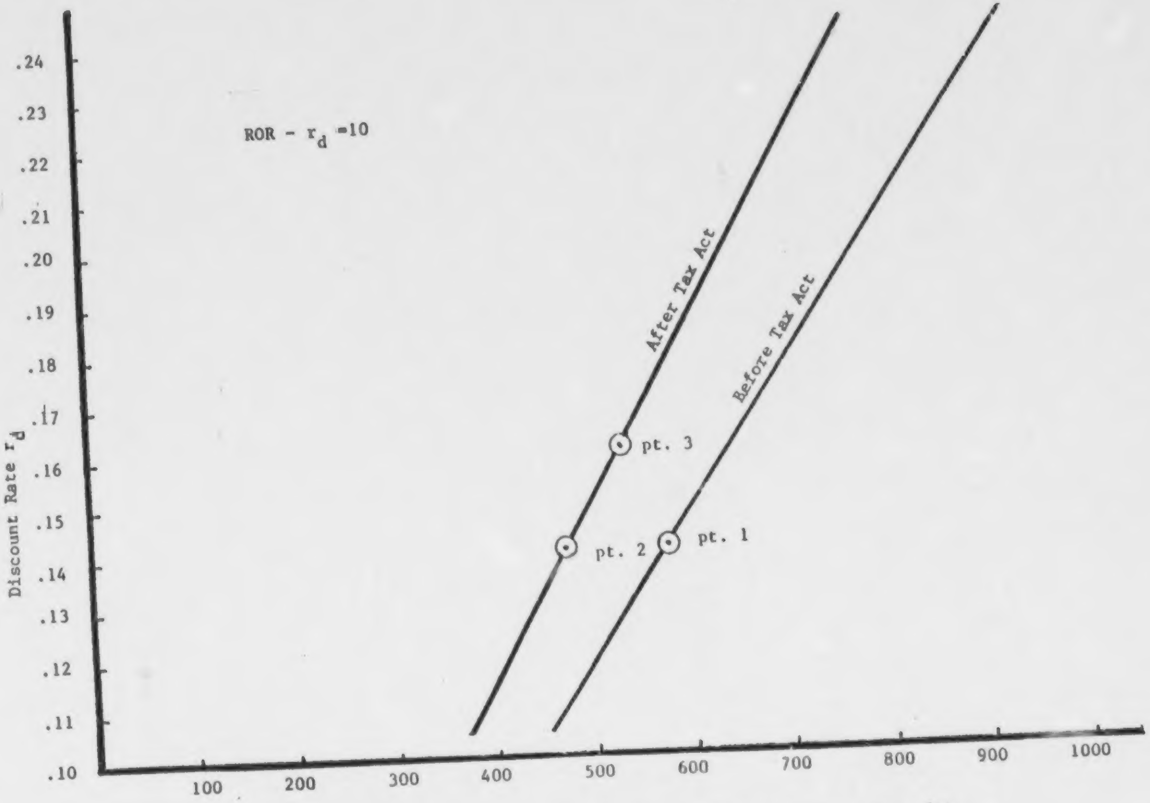


Figure 3. Return required on \$ 1000 investment vs discount rate when ROR - r_d = 10.0

of \$35 per barrel of oil equivalent and assuming it takes 10 percent (\$1,800) of the investment to operate and maintain the equipment purchased, the net first year dollar return on the investment would be \$10,975. The following assumptions were used:*

n = useful life = 15 years

r_e = annual increase in energy costs = 10%

T = tax rate = 46%

b = investment tax credit = 10%

m = depreciation life = 15 years

The ROR is 23.64 percent, yielding a hurdle rate about 10.7 points over the discount rate. When the investment tax credit is increased to 20 percent and the depreciation period reduced to five years, the amount that a corporation like Union Carbide would be willing to invest in a no-risk project capable of saving one barrel of oil per day equivalent would increase to \$21,575, a 20 percent increase.

In January 1981, the yield on long-term Union Carbide bonds was 12.9 percent. In September 1981, that yield was 14.9 percent (representing an increase in the cost of investment capital). This implies that the r_d over this period increased by 2 percent. This increase in the discount rate would reduce the amount of capital that Union Carbide would be willing to invest to save a barrel of oil equivalent to \$19,500 (assuming the same hurdle rate prevails). This represents a 10 percent increase in the rate at which capital would be invested in proven energy saving equipment.

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* These parameters are the same as those used in the hypothetical case analyzed earlier except the discount rate was taken as 12.9% based on the long-term bond rate yield of Union Carbide bonds as of January 4, 1981.

On equipment for which the 20 percent investment tax credit did not apply, the level of investment would be reduced to $18,600 (a 3 percent increase over current level when r_d = 14.9 percent). Thus the rapid depreciation provisions of the Economic Recovery Tax Act have relatively minor effect when interest rates are high.

It can be seen that the Tax Act has the effect of increasing the rate at which "best available technology" will be achieved ranging from 20 percent, under the most optimistic conditions (20 percent ITC, interest rates 2 percent lower than today's), to 3 percent under today's conditions (assuming only 10 percent ITC).

One other facet of the Tax Act bears attention. The relaxation of regulations regarding equipment leasing will significantly stimulate third party investment in debt/profit limited industries (primary metals, cement, glass, etc.). Although third party criteria may be the same as those previously discussed, they are a great improvement over the investment criteria currently limiting these capital intensive industries (where the hurdle rate may be as high as 50 percentage points over the discount rate). It is anticipated that this provision of the Tax Act will result in significant plant modernization for these financially limited industries, and permit achievement of "best available technology" at a rate consistent with the rest of industry.

EVALUATION OF FEDERAL OPTIONS TO INDUCE INDUSTRY TO INVEST IN THE DEVELOPMENT OF HIGH RISK NEW TECHNOLOGY

Thus far this discussion has been concentrated on the response of industry to the incentives offered by the Economic Recovery Tax Act in investing in modern but proven process technology. The program mandated by Congress and conducted by DOE however, has been primarily directed towards the introduction of new, high-risk process technology potentially capable of significant improvement in energy productivity over the best available technology. It has accomplished this purpose through cost-shared projects with industry with the Federal share ranging from 40 percent (for lower risk projects with large companies) to 95 percent (for high-risk projects with small companies). The average Federal share is about 70 percent.

This section will now examine the strength of alternative techniques for achieving the introduction of high-energy efficiency, new process technologies, the reasonableness of this type of Federal investment, and the cost effectiveness of such investment.

The Relationship of Risk to Investment Decisions

A corporation would undertake RD&D in a new process only if it anticipated multiple uses internally or multiple sales externally. This is different than investing in proven technology where purchase of a single piece of equipment must yield an equivalent rate of return equal to the hurdle rate. In this case it is more appropriate to use the economic yardstick known as the internal rate of return (IRR) since multiple uses or sales implies that the income yielded from the first investment is reinvested at the same rate yielded by the first investment. This parameter can be calculated from the equation given in Table 3 by raising the discount rate (r_d) until it exactly equals the calculated ROR.

Several economists have shown that the relationship between probability of failure (risk) and the required benefit (IRR) is an inverse function (ref. 4) expressed by the equation:

$$\frac{(IRR)a}{(IRR)n} = \frac{1}{(1-P_f)^x}$$

where

(IRR)a = the required internal rate of return, on risky projects

(IRR)n = the internal rate of return corresponding to the risk-free hurdle rate. Calculating this value using the Union Carbide investment criteria sited earlier yields (IRR)n = 51%.

P_f = the probability of failure of the project.

x = a coefficient expressing the willingness of the company to undertake risk.

The coefficient x will vary from company to company. When x = 1, the company involved would be extremely willing to accept risk and in fact would not require its risk adjusted (IRR) to be any greater than the inverse relationship accounting for failure probability.* Most companies, however, require x to be considerably greater than 1, reflecting their conservatism in undertaking R&D projects which, if unsuccessful, would have a zero return on investment. Such companies have fewer discretionary investment dollars, and thus few high risk development projects can be undertaken. The failure of any one project, therefore, significantly affects the return on the total capital pool. Thus a premium is placed on such risk as expressed by an exponent greater than 1. In 1976, IP investigated this factor and concluded that for the energy intensive process industries (quite conservative due their capital intensity), x is 2.22 or greater. Figure 4 shows the relationship between the ratio (IRR)a/(IRR)n and probability of failure for these two cases (x = 1 and x = 2.22). For a project having a 50 percent probability of failure, the corporation extremely willing to accept risk would require the projected (IRR)a to be at least twice the (IRR)n (point 1 on the x = 1 curve). In the more likely case of the risk averse process industry the projected (IRR)a to (IRR)n ratio would have to be at least 4.66 (point 2 on the x = 2.22 curve). If one can estimate the probability of failure of a given project it is possible to use these two curves to evaluate the likelihood that a corporation would undertake the project. This point is illustrated by the following hypothetical cases:

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* To illustrate this point consider a company conducting 10 equivalent R&D projects each having a 50% probability of failure. When x=1, the ratio of IRRa/IRRn would be 2 for each project. At the end of the development period one half of the projects would have failed (yielding no return). The other half would succeed yielding twice the nominal IRRn. Thus, the total dollars expended on all ten projects would achieve the nominal rate of return.

- Case 1: A corporation is evaluating an R&D project that it judges to have a probability of failure of 60% and it projects the cash flow from the project, if it were successful, to yield an (IRR)a to be 1.5 times its hurdle rate (IRR)n. This is shown as point 3 on Figure 4. Even the most adventurous firm would reject this project as too risky to undertake.

- Case 2: A second R&D project is judged to have a probability of failure of 60% but if it were successful the (IRR)a would

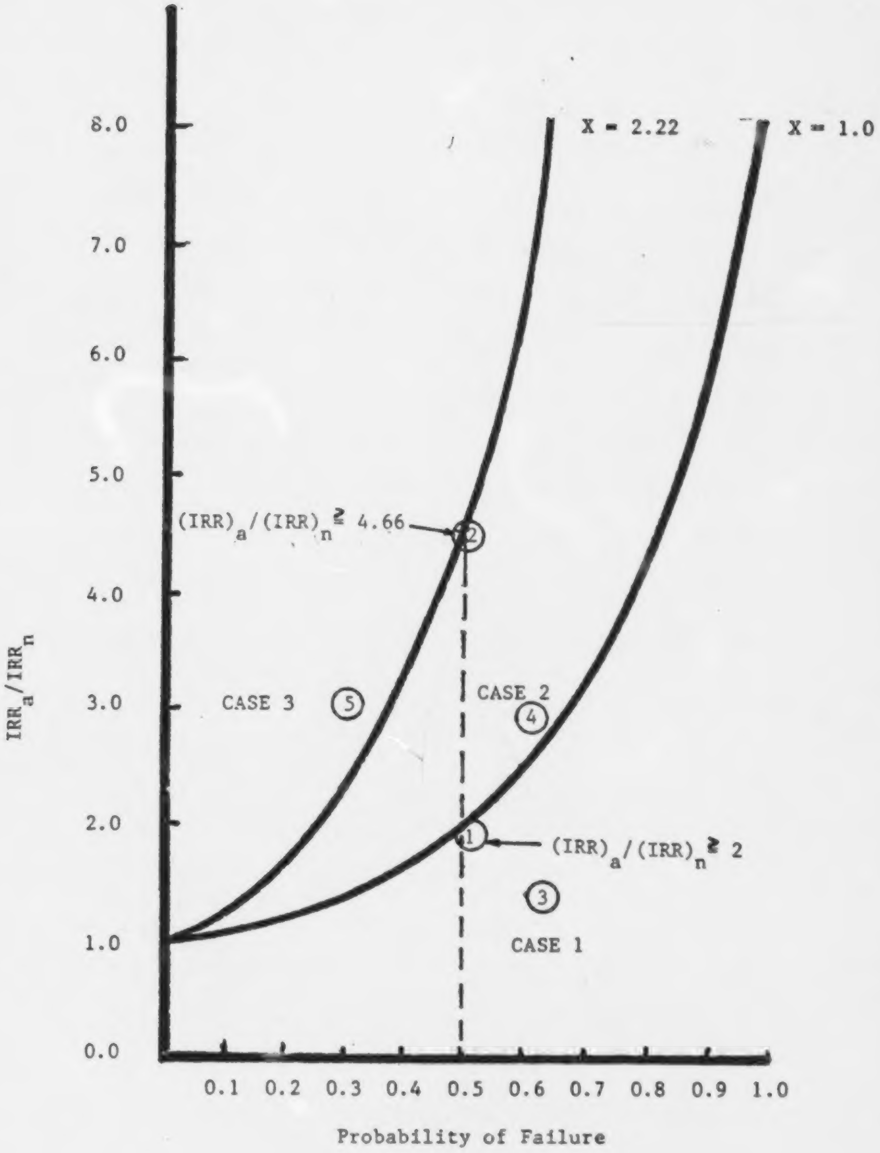

Figure 4

Ratio of IRR_a to IRR_n as a Function of Risk be 2.5 times the hurdle rate (IRR)n. This project is shown as point 4 on Figure 4. Only a corporation extremely willing to accept risk would undertake this project.

- Case 3: A third project is judged to have a probability of failure of 30% and an (IRR)a 3 times the (IRR)n (point 5 on Figure 4). This project would probably be undertaken by even the conservative capital intensive corporation.

These tests will be used later in this paper to evaluate the strengths of various Federal options to motivate industry to undertake process research and development to save energy.

A Description of Three Federal Actions that Could Motivate Industry's Investment in Energy Efficient Process Technologies

There are a variety of options which the Federal Government could promulgate to motivate industry to improve their energy productivity through the research and development of efficient process technologies. In this paper three of these options are included. They are:

1. Permit the inducements created by the Energy Recovery Tax Act to create a climate for RD&D investment. These inducements include 5 year depreciation, 20% investment tax credit to the purchaser (not developer) of selected developed products (this is a very optimistic assumption since the 20% applies to only a few technologies) and a tax credit of 25 percent for one

half the increased RD&D expended by the developer over a base level established over the previous three years. If all new process RD&D were above the base level, this incentive would provide a 12.5 percent tax credit for such work.

2. Federal cost sharing in the development of new, high risk process technology specifically targeted to improve energy efficiency. This option represents a continuation of the activities of IP as mandated by the Non-Nuclear Energy Act of 1974.

3. Refundable Awards to the developer for introducing innovative energy productivity technologies. This is a new concept, not previously evaluated, for motivating RD&D expenditures for improved energy productivity. It is contemplated that the developer would establish the innovative nature of the process by providing evidence of a patent. The value of the energy saved would be documented by records and the developer would receive a one time cash rebate from the Government equal to one half the market value of the energy saved in the first two years after introduction, i.e., (energy saved per unit) times (number units sold) divided by 2-calculated for first two years.

Technologies Selected for Evaluation

The strength of the above Federal options to motivate industry to develop energy efficiency process technologies is tested by using four case studies. The technologies selected for this analysis are among the projects currently under cost-shared funding by DOE. They are:

1. A slow speed diesel engine applied to cogeneration supplying 23 MW of electricity and 2000 psig steam to a chemical plant.

2. An electric driven Rankine two-stage methanol vapor compression heat pump supplying 26 million Btu/hr at 50 psi using waste heat as a heat source.

3. A ceramic recuperator capable of operating at hot side temperature up to 2500°F.

4. A high effectiveness plate fin metallic recuperator operating at hot side temperatures up to 1600°F.

These technologies were selected because they cover a broad range of failure probability, potential marketplace, and Federal cost sharing under the DOE program. They, therefore, represent a family of typical projects against which the previous cited options can be evaluated.

Probability of Failure and Projected Market Penetration

Perhaps the most difficult and controversial element in evaluating the decision to enter into an R&D project is determining the probability of failure. Many factors can cause the investment in the development of a new process to be lost, i.e., yield no return. At the initiation of a project these factors are often unforeseen, so it takes an extremely objective impartial analyst to ask all the "what if" questions such that a reasonable value of the failure probability can be estimated. Six fundamental questions must be answered.

1. What are the technical problems that must be solved for the project to be successfully developed?

2. If the technical problems are solved what is the projected production cost, selling price, and profit to my corproation?

3. At the projected selling price and cost savings what is the equivalent rate of return to my customer (will the system sell)?

4. What is the total market for the product?

5. At the projected selling price how fast will the equipment penetrate the market?

6. Are there factors other than technical and economic that may inhibit the marketability of the product?

The evaluation of these question can lead to estimates of the technical risk, the economic risk and the institutional risk associated with the project.

The current methodology for evaluating these factors used by IP is considered circumspect by the National Materials Advisory Board (ref. 6). Consequently, a narrative methodology outlining the rationale for judgement is used in this paper to estimate the probability of failure for each of the case study technologies.

The failure probability numbers were derived by qualitatively weighing the perceived technical, economic, and institutional problems at the initiation of the project. Considering these problems in each area a success probability and the simple relationship $P_f = (1-P_s)$ was used to calculate failure probability. Obviously, this methodology involves qualitative judgement, but it is exactly the type of judgement the private developer must make in assessing the wisdom of investing in a development program. The results of this evaluation for the four case studies are given in Table 4.

The market penetration figures were derived by using a Bass diffusion curve over 20 or 15 year periods. The curves used are shown in Figure 5. A 20 year period was used for the diesel cogeneration, electric rankine heat pump and ceramic recuperator based on the perception that these projects are significant departures from current manufacturing industry practice. The high effectiveness recuperator project was considered closer to current metallic recuperator practice, and hence, a 15 year period was used for market penetration. The penetration data are presented in Table 5.

Evaluation of Federal Options to Motivate Industry to Develop High Energy Efficiency Equipment

The four cases described are used to evaluate the strength of the three Federal options to motivate industry to develop and market new high

TABLE 4.

Probability of Failure Estimates
(as perceived at initiation of work)

	Diesel Cogeneration	Elect Rankine Heat Pump	Ceramic Recuperator	High Efficiency Recupterator
1. Technical Success Probability (P_{st})	o engine used for years in marine propulsion. o Waste heat boiler relatively standard. o Thermal/electrical interface somewhat difficult. o Environmental emissions and permitting may be problem.	o working fluid (methanol) seal compatibility doubtful. o Thermal breakdown of working fluid possible. o Toxicity/fire hazard with failure. o Temperature entropy map unsure.	o compatability of ceramic with various flue gases unknown. o Thermal shock characteristics unknown. o Casing configuration not resolved - leakage from hot to cold side a problem. o Erosion from flue particulates unknown.	o Simultaneous brazing of hundreds of joints unsure. o Thermal shock characteristics of braze doubtful o Casing configuration not resolved - leakage a problem. o Corrosion of flue gases especially on braze unknown.
	$P_{st} = 0.99$	$P_{st} = 0.70$	o $P_{st} = 0.50$	o $P_{st} = 0.50$
2. Economic Success Probability (P_{se})	o Unit sales price based on good hardware values. o Magnitude of unit price may delay market penetration. o Availability and O&M costs well established. o Installation costs doubtful.	o Unit sales price estimate not based on final design hard- o Development costs unsure. o COP varies with heat source T. o Availability & O&M costs not known.	o Unit sales price estimate not based on prelim. design. o Development costs unsure. o Tooling costs for large market unsure. o O&M costs unsure.	o Unit sales price not sure but better than ceramic. o Development costs unsure. o Tooling costs for markets unsure. o O&M costs unsure.
	$P_{se} = 0.95$	$P_{se} = 0.70$	$P_{se} = 0.60$	$P_{se} = .75$
3. Institutional Success Probability (P_{si})	o Current dependence of engine on liquid fuels may create user doubts on availability and realiability of supply.	o No institutional problems known.	o No institutional problems known.	o No institutional problems known.
	$P_{si} = 0.90$	$P_{si} = 1.0$	$P_{si} = 1.0$	$P_{si} = 1.0$
Total Success Prob (to nearest 5%)	$P_{st} \cdot P_{se} \cdot P_{si} =$ $(.99)(.95)(.90) = 0.85$	$P_{st} \cdot P_{se} \cdot P_{si} =$ $(.70).(.70)\ (1.0) = 0.50$	$P_{st} \cdot P_{se} \cdot P_{si} =$ $(.50)\ (.60)\ (1.0) = 0.30$	$P_{st} \cdot P_{se} P_{si} =$ $(.50)\ (.75)(1.0) = 0.40$
Probability of Failure = $(1-P_s)$	0.15	0.50	0.70	0.60

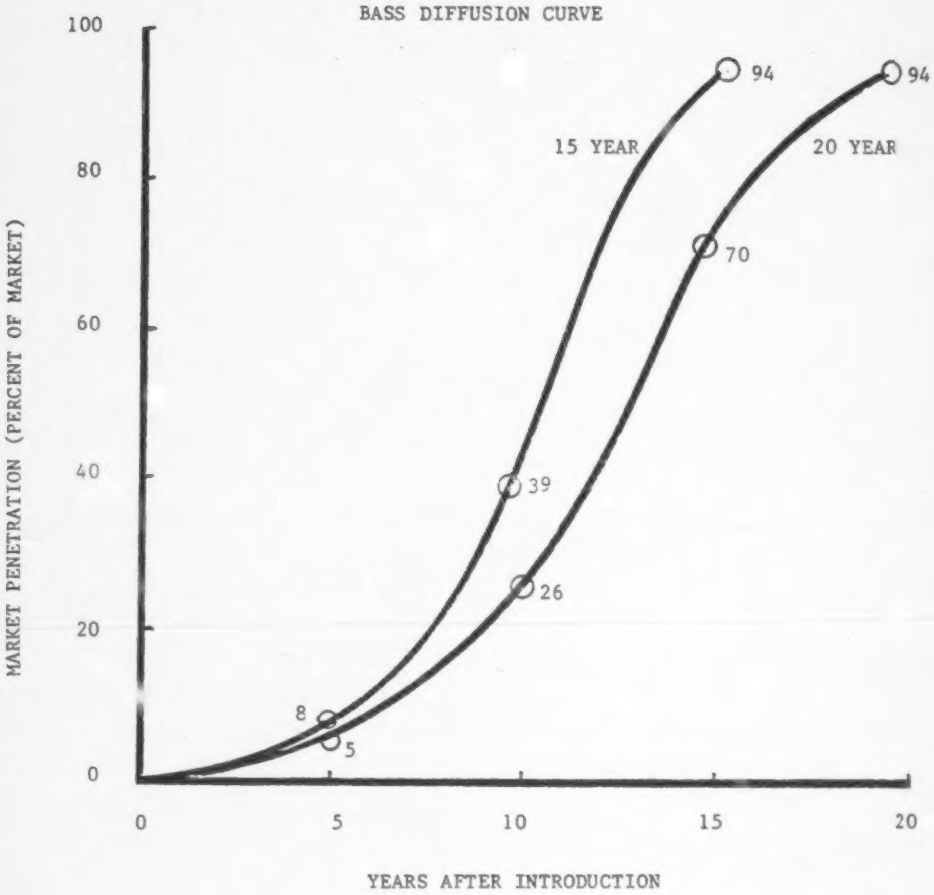

Figure 5. Bass Model Diffusion Curve Used to Project Technology Impacts

Table 5

Estimate of Market Penetration
(over 10 yrs After Development Complete)

	Diesel Cogeneraton		Elect. Rankine Ht. Pump		Ceramic Recuperator		High Effectiveness Recuperator	
Total Market (from Project Eval Sheets)	700		1,200		8,700		64,000	
Year	Units/yr	Total Units sold	Units/yr	Total Units Sold	Units/yr	Total Units Sold	Units/yr	Total Units Sold
1	1	1	3	3	400	400	400	400
2	1	2	6	9	600	1000	600	1000
3	2	4	12	21	900	1900	900	1900
4	3	7	18	39	1200	3100	1200	3100
5	5	12	24	63	1600	4700	1600	4700
6	8	20	32	95	2000	6700	2000	6700
7	16	36	42	137	2610	9310	2610	9310
8	28	64	51	188	3480	12790	3480	12790
9	35	99	63	251	4350	17140	4350	17140
10	49	148	86	337	6090	23,230	6090	23,230
10 year percent saturation of market	21%		28%		27%		36%	
Penetration curve Lifetime	20 yrs		20 yrs		20 yrs		15 yrs	

efficiency equipment. In this evaluation the cost benefit to all parties at interest (the developer, the eventual user, and the Federal government) is determined and compared with standards established earlier. Using such tests, conclusions regarding whether or not such projects would have been undertaken will be drawn.

Table 6 considers the cost benefit to the developer. The lines 7a, b, and c show the internal rate of return to the developer under the three options discussed earlier. Using the no risk (IRR)n of 51% derived earlier it is possible to evaluate (IRR)a/IRRn for each option. These data are summarized below:

TABLE 7. SUMMARY OF IRRa/IRRn FOR EACH FEDERAL OPTION

	IRRa/IRRn			
Option	Diesel Cogen	Electric Heat Pump	Ceramic Recuperator	High Effect. Recuperator
a. Allow National Recovery Tax Act to Motivate	0.705	.96	1.19	0.81
b. Cost Share RD&D	0.81	1.83	3.44	2.78
c. Federal Bonus Plan	0.74	1.46	2.67	1.15
Probability of Failure	0.15	0.50	0.70	0.60

Figure 6 plots these data and also plots the x=1 indifference curve (the locus of points above which a corporation extremely willing to accept risk will probably conduct RD&D). Comparison of the points with this line provides insight into the motivating power of the three options. The following conclusions are drawn:

COST BENEFIT TO THE DEVELOPER

	PROJECT											
PARAMETER	DIESEL COGENERATION			ELECTRIC RANKINE HEAT PUMP			CERAMIC RECUPERATOR			HIGH EFFECTIVENESS METALLIC RECUPERATOR		
1. Estimated Development*[1] Cost	$22 million			$3.265 million			2.3 million			1.475 million		
Federal Share[1]	8.48 million			2 million			2.1 million			1.3		
Private Share[1]	13.26 million			1.265 million			.2 million			.164 million		
2. Time of Development[1]	5 years			7 years			4 years			4 years		
3. Future Value of Development Costs at start of market introduction[2]	27.2 million			4.56 million			2.69 million			1.7 million		
Federal Share	9.7 million			2.93 million			2.45 million			1.52 million		
Private Share	17.5 million			1.63 million			.24 million			.18 million		
4. Tooling Costs for Production[3]	0			0			.20 million			.10 million		
5. Profit Per Unit Sold[4]	1.0 million			0.06 million			.0013 million			.0006 million		
6. Cash Flow Per Year[5]	Units Sold	$(mill)		Units Sold		$(mill)	Units Sold	$		Units Sold		$
Year 1	1	1.00	5.23(8)	3	.18	3.99(8)	400	.52	3.64(8)	400	.29	.66(8)
2	1	1.10	5.75	6	.40	4.47	600	.85	6.0	600	.40	1.10
3	2	2.42		12	.87		900	1.42		900	.65	
4	3	3.99		18	1.44		1200	2.07		1200	.96	
5	5	7.30		24	2.10		1600	3.04		1600	1.40	
6	8	12.88		32	3.09		2000	4.19		2000	1.9	
7		28.32		42	9.46		2610	6.0		2610	2.8	
8	28	32.20		51	6.0		3980	8.6		3980	4.1	
9	35	74.90		63	8.1		4350	12.1		4350	5.6	
10	49	115.64		86	12.2		6090	18.1		6090	8.6	
7. Internal Rate of Return to Developer												
a. En. Rec. & Tax Act[6]	36.1%			49.21%			60.9%			41.4%		
b. Federal Cost Sharing[7]	41.4%			93.6%			175.6%			142.0%		
c. Fed. Bonus Plan[8]	37.3%			74.7%			136.1%			58.9%		
8. Probability of Failure[9]	.15			.5			.7			.6		
9. Risk Adjusted (IRR)$_a$ x=2.22	71.7%			249%			767%			405%		
Required if: x=1.0	62.4%			106%			176%			132%		

NOTES:
1. Data obtained from IP. Project Data Sheets.
2. Based on 10% inflation figure from time development $ are spent to start of market penetration.
3. No tooling costs assumed for diesel since equipment already being built. Other values are estimated.
4. Profit per unit based on 10% of projected selling price (obtained from IP Data Sheets).
5. Market Penetration from Table 4. Cash based on profit per unit times 10% inflation factor per year.
6. Based on 87.5% times the future value of the total Development Cost plus tooling costs.
7. Based on future value of private share of Development Costs plus tooling costs.
8. Based on future value of total cost plus tooling cost as invested. First two year cash flow increased by 1/2 value of energy saved.
9. From Table 3.

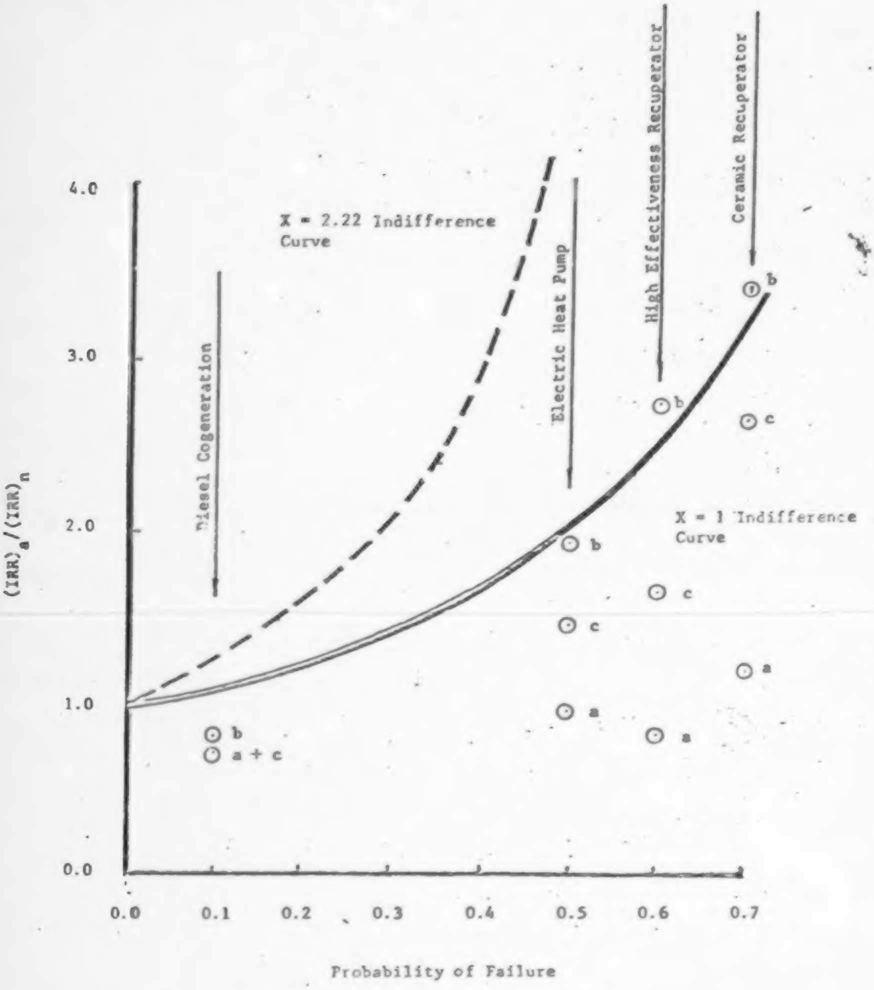

Figure 6

Test of Strength of Options a,b, and c by Comparing IRR$_a$/IRR$_n$ to the X = 1 Indifference Curve.

Option a: The National Recovery and Tax Act does not provide sufficient motivation to induce even the most risk taking industry to undertake RD&D in energy productivity projects. This becomes acutely apparent as the probability of failure increases (compare points (a) with the x=1 indifference curve).

Option b: Federal cost sharing of RD&D projects as currently conducted by IP brings the IRRa/IRRn ratio of the projects studied very close to the x=1 indifference curve providing the necessary motivation to induce corporations very willing to accept risk to undertake like energy process development projects. It is the only option studied which achieves this goal.

Option c: The Federal bonus plan has significant potential of providing the necessary motivation. As configured in this paper it is not sufficient but increasing the award value and time period given may be an interesting non-intrusive alternative to direct cost sharing. Its administration may be difficult, however.

Benefits of Advanced Process Development to the Using Industry

The corporation which purchases the successfully developed equipment derives benefit from such development only if the device provides an equivalent rate of return (ROR) equal to or greater than the corporate hurdle rate. Table 8 compares the ROR for the four cases based on

Table 8

Estimated Equivalant Rate of Return to User of New Equipment Project

		Diesel Cogeneration	Electric Rankin Heat Pump	Ceramic Recuperator	High Effectiveness Recuperator
1.	Projected Sales Price 2)	$10.72 million	$.705 million	$.0125 million	$5 thousand
2.	Projected Installation Cost 1)	$ 1.35 million	$ .675 million	.0035 million	1 thousand
3.	Total Unit Cost to User	$13.07 million	$1.38 million	$0.16 million	$6 thousand
4.	Projected Value of Energy saved per Unit per year,	$8.43 million	$.617 million	$.0078 million	$2.12 thousand
5.	ROR to user 2)	26.36%	23.6%	24.2%	22%
6.	Hurdle rate ROR3)	25.0%	25.0%	25.0%	25%

Notes

1. From Project Data Sheets
2. Calculated using Energy Recovery Tax Act provisions (20% ITC and 5 year depreciation)
3. Based on earlier calculations for proven technology

projected sales price, installation costs and estimated savings. It is seen that each project has an ROR of the order of the hurdle rate ROR established by Union Carbide data and probably will be acceptable in the marketplace.

Benefits of Advanced Process Development to the Federal Government

An often overlooked aspect of increasing industrial energy productivity is the direct cash benefit that accrues to the Federal Government. As has been previously stated the direct cost sharing of high risk development projects is the only option studied capable of providing motivation to the developer. The taxpayer, however, deserves a return on his investment in such projects, and indeed he gets it. This return occurs because increasing energy productivity directly increases the profits of the corporation using the process and the use increases the taxes paid by that corporation. To analyze the value of this return it is necessary to determine: the total number of units in operation, the dollar value of the energy saved per unit, and the probable taxes paid by the corporations using the equipment. The first two factors can be easily obtained from the project description sheets and market penetration curves. The third factor requires an estimate of the percentage of the savings paid in taxes. A corporation normally pays 46% income tax on profits. A conservative approach, however, to determining the return to the treasury is to assume that a portion of the total increase in productivity is passed on to the consumer as lower costs. Thus it has been assumed that only 20% of the increased profits arising from each process introduction is returned to the treasury.

Since, in the cost sharing program a number of projects will fail, the return anticipated from any given project, must be discounted to account for this probability of failure. The risk discounted IRR accuring to the Treasury for the four cases studied are given in Table 9. It is observed that the risk adjusted IRR to the Treasury ranges from 27% to 78% for these projects. This represents a return on investment rarely seen for the expenditure of Federal funds. Assuming an average failure rate of 40% across all projects funded and an average unadjusted IRR of 92%*, the risk adjusted IRR is 38%. The tax payer is receiving a 38% return on his investment each year, and at the same time significantly reducing the nation's dependence on foreign energy.

It can be argued that the purchaser of the advanced equipment would have invested that capital in other investment opportunities yielding the same ROR were this newly developed equipment not available. Thus, such advocates would say, that the return to the Federal government is not increased by cost shared RD&D. This argument is countered by the following logic:

- The number of discretionary investment opportunities directly related to improved energy productivity which yield the hurdle rate ROR of 25% is relatively limited.

- The alternative investment opportunities yielding the required ROR are not necessarily related to energy productivity, e.g.,

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* Calculated using the total Federal investments and cash flows for the case studies (excluding the diesel congeneration project which is considered to be too profitable to the Federal government to be considered typical).

Table 9.

IRR to Federal Governmnt Based on their Cost Share in Development Projects Projects

1. Cash Flow to Federal Govern-ment1)	Diesel Cogeneration		Electric Rankin Heat Pump		Ceramic Recuperator		High Effectiveness Metallic Recuperator	
Year	Cumulative Units in year (#)	Cash Flow Treasury (millions)	Cumulative Units in year (#)	Cash Flow Treasury (millions)	Cumulative Units in year (#)	Cash Flow Treasury (millions)	Cumulative Units year (#)	Cash Flow Treasury (millions)
1	1	1.5	3	.63	400	0.62	400	.17
2	2	3.53	9	1.64	1000	1.72	1000	.45
3	4	7.67	21	3.34	1900	3.59	1900	.91
4	7	14.33	39	5.83	3100	5.32	3100	1.57
5	12	26.63	63	9.47	4700	10.70	4700	2.55
6	20	48.33	95	14.49	6700	16.83	6700	3.91
7	36	96.13	137	21.7	9310	25.71	9310	5.85
8	64	176.1	188	32.3	12710	38.66	12710	8.71
9	99	302.0	239	46.8	17060	56.95	17060	12.61
10	148	497.0	325	69.2	23150	84.87	23150	18.65
Future Value of Fed Cost Share at start of market introduction	$9.68 million		$2.93 million		$2.43 million		$1.53 million	
IRR to Fed Treasury	91.3%		90.7%		104%		68%	
Risk Discounted IRR X = 1	77.6%		45.4%		31.3%		27.2%	

Notes:

1. Cash flow to treasury calculated by determining total energy saved by all users in each year - calculating total value of energy saved (using 10% inflaton per year) and assuming 20% of cash value is returned to treasury in taxes (remainer of savings go to reduced price of product and to profit of company).

purchase of an oil company by a steel company, or a car rental business by a retailer.

- Although the return to the Federal government may be the same for corporate investments not related to improved energy productivity such return is not attributable to a reduction in energy demand, a major national goal.

- The reduction in energy demand is exactly equivalent to increase in energy supply. Thus to accurately assess the relative worth of the Federal investment in cost shared RD&D to improve energy productivity it should be compared with the Federal investment in energy supply.

There are two types of subsidy the Federal government provides for the production of oil and gas - an exploration and development subsidy and a depletion allowance. The first of these is analogous to permitting expensing RD&D costs in the energy consuming industries and will not be considered here. The second, however, is a subsidy which has no direct analogy in the energy consuming industries.

The depletion allowance may take one of two forms - cost depletion or percentage depletion (ref. 7). Cost depletion pro-rates the allowance based on the annual production divided by the total reserve in a deposit, while percentage depletion permits an allowable percent of the gross sales price of the commodity to be deducted from the revenues. For oil production the percentage depletion is usually applied. The allowable depletion formula for oil and gas is as follows:

1981 - 20%
1982 - 18%
1983 - 16%
1984 - 15%
Future years - 15%

In no case may the allowable percentage exceed 50% (65% for independent producers) of the taxable income from the property. Percentage depletion may be used as long as the property is producing even though the basis of the property may be reduced to zero through prior depletion.

To calculate the return on investment to the Federal government, a hypothetical new oil well will be postulated. The following assumptions will be made:

- The new well produces initially 1000 barrels of crude oil per day, but the calculation will be based on a per barrel basis.
- The production from the well will decrease linearly by 5% of its initial production, per year as the oil is extracted. This is consistent with published data that the average production from a well after ten years is one half the initial production (ref. 9).

- The well head price of the crude oil is $35.00 per barrel in 1981, but increases 10% per year in succeeding years (consistent with previous calculations of IRR for consuming industries).

- The 1979 pretax profit to the producing company is 12.4% and the company's tax rate is 46%, yielding a 5.7% net profit after taxes (ref.8). These numbers are based on a 1979 average well head price of oil of $12.64 (ref. 9) based on constant 1972 dollars.

- The pretax profits on the new well under consideration is 18% obtained by applying the 1980 GNP deflator (13% greater than the 1979 deflator of 165.5 or 187) to the $35.00 well head price.

Table 10 calculates the IRR to the Federal government over a ten year period (consistent with previous calculations) for the depletion allowance investment. This IRR of 28.27% compares with the risk adjusted average Federal IRR of 38% for cost shared RD&D supplied to the consuming industries. It is concluded that the investment in RD&D to save energy is significantly better than the investment to improve energy supply and does not deplete oil and gas reserves.

Due to its unique ability to tax corporate profits, the government is the only party that can receive this cost benefit. Neither the developer not the user can reap the benefit associated with the cumulative sales of energy efficient equipment. Since each benefit is

TABLE 10
IRR TO FEDERAL GOVERNMENT ON NEW OIL WELL
(based on depletion allowance per barrel produced)

					Depletion Allowance						
Year	bbls Produced(1)	Inflation Factor	Gross Sales($)	Pretax Profit$(18%)	50%Test(2) $	Allowable Percentage	$Allowance based on %(3)	Allowance $(4)	Sales less Depletion $	Tax(5) Income $	Net Cash Flow to Govt.$(6)
1981	1.0	1.0	35.00	6.30	3.15	20	3.22	3.15	31.85	2.63	-0.51
1982	0.95	1.1	36.75	6.62	3.31	18	3.04	3.04	33.71	2.79	-0.25
1983	0.90	1.21	38.12	6.86	3.43	16	2.80	2.80	35.32	2.92	+0.12
1984	0.85	1.33	39.57	7.12	3.56	15	2.73	2.73	36.84	3.05	+0.32
1985	0.80	1.46	40.88	7.36	3.68	15	2.82	2.82	38.06	3.15	+0.33
1986	0.75	1.61	42.26	7.61	3.80	15	2.92	2.92	29.34	3.25	+0.34
1987	0.70	1.77	43.37	7.81	3.90	15	2.99	2.99	40.38	3.34	+0.35
1988	0.65	1.95	44.36	7.98	3.99	15	3.06	3.06	41.30	3.42	+0.36
1989	0.60	2.14	44.94	8.09	4.04	15	3.10	3.10	41.84	3.46	+0.36
1990	0.55	2.36	45.43	8.18	4.09	15	3.13	3.13	42.30	3.50	+0.37
1991	0.50	2.59	45.32	8.16	4.08	15	3.12	3.12	42.20	3.49	+0.37
										IRR =	28.27

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(1) Assumes production decreases linearly such that production after 10 years is one half initial production.
(2) Calculated maximum dollar depletion allowed as 50% of pretax profits.
(3) Calculated dollar depletion allowed based on percent allowable times sales times tax rate (46%).
(4) Selects lesser of 2 or 3.
(5) Based on gross sales less depletion times pretax profit (18%) times tax rate (46%).
(6) Calculated by tax income minus depletion.

of great importance to the nation in terms of reduced energy demand, it is only logical and equitable that the government expend the funds in cost shared RD&D which enables the benefit to be realized.

CONCLUSIONS AND RECOMMENDATIONS

The preceding analysis has shown:

1. The incentives offered by the Economic Recovery Tax Act will provide industry with some incentive to increase the rate at which best available technology is introduced. The increased rate ranges between 3 and 20 percent depending on the discount rate.

2. The interest rate is a far more important factor than the Tax Act itself in accelerating the rate at which best available technology is introduced.

3. In the absence of direct Federal cost sharing in RD&D projects there are no incentives enacted or contemplated which would significantly accelerate RD&D in high risk new technology to improve energy productivity.

4. The cost effectiveness to the Federal government of cost shared RD&D is extremely high, averaging a 38% return per year on all monies invested after discounting for risk.

5. The Federal Government's unique ability to tax a corporation's increased profits occasioned by increased energy productivity, makes it the only party involved that can reap such benefits.

It is strongly recommended that this program of cost shared RD&D be continued at an increased level. The benefits to the Treasury resulting from increased productivity could well offset the deficits currently contemplated.

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Mr. SISSINE. Our next speaker will be Phil Huyck. Phil trained for the law in California and has practiced law in New York. He is now vice president of Project Finance, specializing in the area of cogeneration, at First Boston Corp.

[A biographicial sketch of Mr. Huyck follows:]

Philip M. Huyck is Vice President—Project Finance, in the Corporate Finance Department of the First Boston Corporation. He has primary responsibility for project financing for regulated industries with special focus on synthetic fuel, cogneration and renewable resource projects. He previously practiced law with the New York City firm of Cravath, Swaine & Moore. Mr. Huyck received his B.A. and J.D. degrees from Stanford University and is a member of the New York and California bars.

STATEMENT OF PHILIP M. HUYCK

Mr. HUYCK. It is always difficult to know where to start in the effort to bridge the communications gap between technically oriented people and financial people.

I want to characterize First Boston as an example of an investment bank and try to give you some idea of the character and the magnitude of the problem, not only the energy problem generically, but also as we see it from a financial perspective related to our industrial and utility clients.

We have the advantage of being a day-to-day participant in this process, as people come to us to try to raise money for projects in the capital markets.

I should tell you that despite the pin-striped uniform that we wear, we are very pragmatic people. We get tested every day: can we raise the capital, at what price, and under what circumstances?

Investment banks are intermediaries, not like commercial banks which have sources of capital that they draw from depositors and others. Without that earning base, investment banks have to live by their wits.

The premise that I start with in looking at the financial problems in this area is that we are in a time of transition for industry and for utilities. We are moving from what had been a low cost, high availability, very attractive fuel—namely oil—to a high cost and very unstable supply. All of which occurs in a way which is linked to the inflationary environment.

Let me review with you briefly who the players are in this process, what their needs are, and try to place that in a capital market context. Then I will discuss with you what some of the implications are in terms of raising capital for energy efficiency, what some of the windows may be and some of the opportunities. Finally, I will address what the Federal Government can or cannot do in order to either encourage this process or get out of the way of its evolution.

There are three basic players: industry, utilities, and the capital markets.

Industry has a need to retool its energy infrastructure, usually to accommodate new sources of fuel to back out oil or gas.

Utilities, who are really the unrepresented constituency to some extent here today, find themselves in a very strained financial position with neither the financial resources nor in many cases the management attitude to adjust to the new environment. I think what we all saw in the 1978 legislation was, to some extent, at least a partially conscious reflection of the fact there was a certain lack of confidence in the utility industry to take full responsibility for the energy transition.

Lastly, we have the capital markets, an area that I am reasonably familiar with. What has evolved there over the last few years is increasing volatility, increasing instability, and windows where industrial America rushes to market over a very short period of time when rates come down or appear to be coming down. This situation is particularly uncongenial to utility financing, which needs a long-term predictable source of funds. Most of the utility financial executives that you talk to would harken back with a certain amount of nostalgia to a decade ago, both in terms of the way they were perceived and the terms of sources of capital they had available to them.

What you can expect to see may be represented by the attitude that has been reflected publicly by the big institutional players that represented for most of American industry a reliable, stable, long-term fixed rate source of capital. That market is gone and not likely to return. You cannot get—under any circumstances—long-term fixed-rate debt. I exaggerate slightly for effect. But basically, we have gone to a much shorter maturity environment, which means it is much more difficult to plan and assess. If what was a constant in the investment process has suddenly become an extreme variable, that adds a certain element of instability to your calculation and makes people even more reluctant to invest.

The question that comes now is how do all those factors flow together: First, the need by the utility industry to fund and complete a program which may be outmoded before it is completed, because it takes such a long construction time to build a plant; second, the perception by industry that their rates are going up in terms of their electricity costs, that they may not be able to rely on the utility industry to continue to supply them, and that may have to make capital investments to supply electricity—an investment that was never planned for or in their budget in the past; third, all this has to be accomplished in a volatile capital market where the window may simply be slammed shut even for those who are prepared to make that investment.

The old wisdom in the financial community was that first you made the investment decision, decided what you wanted to invest in, and then you turned around to a very comfortable capital market and made the financing decision: what market do I go to?

Increasingly in the corporate context, these two decisions have become linked. I spent all day yesterday talking to a major industrial client who has canceled an investment and is looking for some funds to finance hydroelectric projects which it has available but has not pursued.

Unless you can come up with a new source of capital, the investments simply are not getting made.

That leads me to the question, and I will raise it briefly—and I hope this is a small enough meeting this will be a dialogue—and I will be happy to answer questions about specific issues later on.

Who is going to fill the funding role?

One example of potential new players: institutions who no longer lend fixed-rate debts are interested in investments that provide an attractive inflation-hedged return.

It is possible that at least one aspect of the conservation problem could be solved, in part, through the investment process. In the electric generation area, small power production and cogeneration can be encouraged by allowing institutional investors to participate as equity partners in an investment process that would mobilize capital otherwise unavailable. We have had conversations to that effect, and there is interest. I suggest to you that these new players could contribute a great deal to accelerating the process of cogeneration and small power production.

That is the good news.

The bad news involves the role of the Federal Government. There has been a tragically inconsistent approach to dealing with the deregulation and pricing of power from these projects—to the point where an appetite that was built up and an interest that peaked, have begun to wane.

Let me put it this way. I can function and mobilize capital from large institutional sources, potentially large sources of investment capital, with any given set of rules—if they are consistent over a period of time. There may be a qualitative difference in the amount of capital I can raise, depending on what returns are required and what risks are being taken. Despite this difference, some projects would get financed if the rules would stay in place and be consistent for the period of time it takes industry, the utilities and the investment community to analyze what the investment opportunities are.

If you do not keep the rules consistent over a period of time, no investments will be made.

The unheard-from constituency is the investment community, because they have alternatives.

If you have to retrofit a facility, one way or another you may come up with the capital. Imagine you are a major insurance company, you are looking at investment opportunities, and someone comes to you and says, "I would like you to joint-venture a cogeneration plant in California." Just as you are prepared to commit funds to the project, the rules of the game are upset by a court ruling or by changes in Administration policy. You do not need the extra add-on of complexity. You are likely to withdraw from the cogeneration investment option in favor of other less confused opportunities, such as real estate and leveraged buy outs. That has been a major detriment to mobilizing a fairly deep source of capital. If you ask what the role of the Federal Government might be--and this may be pie in the sky—it should be to have a consistent policy for a sufficiently long period of time that people could assimilate the rules and make investment decisions based on them.

Is my time up?

Mr. SISSINE. Four minutes.

Mr. HUYCK. I will bequeath the extra minutes to my colleagues on the panel.

[The prepared statement of Mr. Huyck follows:]

FINANCIAL ASPECTS OF COGENERATION PROJECTS

Philip M. Hyuck

The First Boston Corporation

Introduction

I will try to accomplish two goals in this brief period. First, to establish a sense of historical perspective on cogeneration, to give us a sense of what is happening to us. No technology is ever successful — or even relevant — unless there is a perceived need for its benefits. Second, to give you a superficial overview of the main areas of concern and the basic ownership and financing alternatives in financing a cogeneration project.

Historical Perspective

It is by now a cliche to say that cogeneration with its increased energy efficiency is relevant -- or perhaps more accurately, relevant again. Nor is it any great secret or insight that when cheap and available fuel becomes expensive and interruptible, adjusting the energy infrastructure to the new environment becomes critical. In short. we are in a period of transition.

Periods of transition and adjustment can pose enormous difficulties. Weaknesses and flaws that existed hidden from view suddenly become painfully obvious, and not all the inhabitants of the old environment survive the transition. Those well positioned or with greater foresight may actually benefit in the new environment. Let me give you two historical examples of transition periods and the lessons they offer. After all, as Santayana's well known phrase goes: those who not learn from history may be doomed to relive it.

To my mind, the most interesting and most cataclysmic failure to adjust is not a very recent one. In fact it is of interest not to engineers and bankers, but paleontologists. Let me take you back to the end of the Mesozoic era. The dinosaur was the end product of 140 million years of evolutionary adjustment. Yet when a major change occurred in the earth's climate some 60 million years ago, this finely tuned machine suddenly and totally disappeared in one of history's great mysteries. Experts debate what caused the change in climate and what it was in the changed environment that proved so suddenly fatal. Basic causes range from a major meteor that effectively filtered out much of the sun's light to a shift in tectonic plates. And the immediate cause is also a source of debate. Was it a change in plant life or certain basic foods that broke the chain of life? One of the more interesting theories holds that the change in climate effectively killed off certain plants whose seeds acted as a natural laxative for these huge animals. This school believes that the proximate cause of the extinction was constipation. Anyone who has been working to get a cogeneration project through the pathetically inconsistent regulatory and tax system in the last few years can sympathize with the frustration they must have felt.

Whatever the cause, the result was clear. The dominant species disappeared suddenly and totally, leaving the world to the smaller, less significant, but more flexible mammals. The lesson, of course, is that failure to adjust — no matter how big you are and no matter how long you've been around — failure to adjust can be terminal.

A second, more modest, perspective is offered by a more recent transition. With the population growth in Europe in the 15th and 16th centuries stemming in part from ploughing techniques that allowed destruction and cultivation of former forests, wood became increasingly scarce. There are chronicled examples of people freezing to death in England and elsewhere for lack of fuel. The welfare recipients dying in unheated tenements on cold winter days in New York City are not the first to suffer this indignity. In desperation, England turned to using a hard black rock buried beneath the earth and ushered in the era of non-renewable hydrocarbon fuels as our energy source. Steam engines, which had existed since the ancient Greeks, suddenly became necessary to bring air into and water out of underground mines. Railroads eventually developed in large measure because existing dirt roads could not handle the transportation in wet and snowy weather of heavy loads of coal from increasingly distant sources. The Industrial Revolution had begun.

Where we are headed with our transition I am not able to tell you. What you can expect is a great deal more instability at all levels -- personal, national and international -- as society adjusts (hopefully!) to the new environment. Unfortunately history also tells us that scarce crucial resources are the most frequent cause of war, whether it's the Romans stripping Spain of its metals 2000 years ago or the conflicts

Let's focus more narrowly -- and slightly more comfortably -- on financing cogeneration. The markets to which industry must turn to finance the transition to a more appropriate energy infrastructure are themselves in disarray. You can expect to see markets characterized by great volatility and instability. The bulwark of the U.S. long-term, fixed rate capital market, the life insurance companies, are themselves undergoing a sea change and are not likely to reemerge in the foreseeable future as purveyors of 20 or 30 year fixed rate debt. The maturity will be shorter and some form of equity participation a likely requirement to get their attention.

Financing Alternatives

With the stipulation that any information on the situation in the capital markets has a very short useful life, let me focus on some financing and ownership alternatives for cogeneration projects. My first point is that cogeneration as a generic category is so diverse that it is difficult to generalize. A diesel generator in the basement of a yoghurt factory in Queens has very little in common with a synthetic fuel multi-hundred megawatt heavy oil recovery project in California. With this caveat, I will try to touch on common areas of concern. My second point is that when I talk about third party financing, there are significant differences in lender/investor attitudes depending on the type of financial institution we talk about -- e.g. commercial banks vs. insurance companies, etc.

Relevant Factors

In looking at financing and ownership alternatives, a number of key factors must be kept in mind. You must work with a sort of analytical grid. Each time you alter the structure to deal with one element, you have to review it carefully from the standpoint of each of the others. The list is not exhaustive, but is certainly illustrative.

Remember that a number of these concerns are relevant whether you are looking at a wholly-owned project or one that is jointly owned and/or third party financed. Both you and any third party investor are engaged in a risk/reward assessment and allocation process. The only difference between you is your capacity to define and willingness to accept certain risks.

Financial. One of the key questions in this area is the capital constraint position of the cogenerator. In most of the situations I've seen, even those companies who can get budget allocations for two or three projects begin to run into resistance when they find another five or six good potential cogeneration projects in their system. In brief, nearly everyone will be in a capital constraint mode, if only in the competition for internally available funds. I have often encountered the situation where the energy manager who can point to a higher rate of return on his investment loses out in the budget battle to the mill manager, because the latter is in the main line of business. Let me say also, by the way, that some energy managers are scoring points with the argument that the cogeneration investment is absolutely necessary not so much because of the potential return as much as the insurance factor. Utilities are increasingly telling their big industrial customers that electricity curtailments are a very real possibility in the next few years. Without inhouse capacity, a refinery, paper mill or petrochemical facility could face curtailment of electricity and cutback or elimination of its operations. The traditional wisdom in finance has been that first comes the investment decision, then comes the financing decision. Increasingly the financing decision is part of the investment decision. No money means no equipment, regardless of the payback and energy saving arguments. One way -- perhaps the best way -- to help break the capital constraint logjam is to make the projects directly self-supporting. This would involve setting up a new entity which would own the cogeneration facility and sell steam to the industrial and electricity to the utility. The entity would issue its own debt, which would be recourse only to the assets and cash flow of the project and not to the parent participants. I will discuss this concept in more detail later.

A second issue in this area is the present and projected tax position of the cogenerator. As we will see, this assessment has a major impact on the decision whether to transfer the tax benefits under the new tax law. I'll develop this theme in more detail later.

Legal. Perhaps the most critical legal concern is the status of the Public Utility Regulatory Policies Act and its implementation in the particular state of operation. I don't want to dwell on this subject, since each situation is unique. You should all be reasonably aware of the structural status of PURPA. All I can do is emphasize the significance of this from the perspective of a third party investor, particulary an institutional lender which may also take an equity interest in a cogeneration facility. The recent decision by the Circuit Court of Appeals for the D.C. Circuit is an unfortunate development in that it casts doubt on the PURPA framework. Confusion can be as fatal to mobilizing third party, non-recourse capital as bad project economics.

Keep in mind that PURPA exemption means the facility is not public utility property under the Internal Revenue Code, since it is not regulated as to the rates it may charge for power. Public utility property status is not one to which you should aspire. It results in the loss of the energy tax credit (to the extent that survives at all) and puts you at best in the 10-year and probably the 15-year property category under the new accelerated cost recovery program instead of being 5-year property. In short, the financial deck is stacked against utility ownership of more than 50% of a cogeneration project.

Indenture. Any financing structure should be examined from an indenture standpoint, particularly to assess the treatment of project finance debt and indirect credit supports. Interest coverage and other limitations can be a major barrier to mobilizing the financing necessary for new investments. These limitations are particularly relevant for utilities which are coming close to the allowable limits on issuance of mortgage bonds.

Tax. The tax area is a critical one and unfortunately one of the least stable. At one point recently there was some realistic hope that the cogeneration tax credit would actually be expanded. Now it looks as though the Administration may be pressing in the opposite direction. This kind of unpredictable treatment of tax benefits contributes very little to the decision-making process. My experience is that the tax credit is not viewed as a reliable benefit and so is usually discounted. The cogeneration tax credit itself (as opposed to the alternative energy or specially defined property credit) is relatively modest even when available.

The changes in the new accelerated cost recovery program should be beneficial in at least two major ways. First, the accelerated write off enhances the attractiveness of any capital investment. Second, the liberalized "safe harbor" lease provisions effectively allow the sale of the tax benefits under what we call a tax benefit transfer. I can spend more time on how this actually functions later, if you wish, but accept my premise for the purpose of this discussion that the potential sale of tax benefits allows a cogenerator in a low taxpaying position to take better advantage of benefits which would be postponed or even lost by selling the tax credit and accelerated depreciation benefits for cash.

In some cases cogeneration may qualify for tax-exempt financing, for example a wood-fired facility that could qualify as a solid waste disposal facility. However, the revenue bond area is continually under attack, along with tax benefit transfers and the energy tax credits, and investors cannot be sure that any of these options will continue to be available.

In any event, you should be aware of the anti-double dipping provisions of the Internal Revenue Code that prevent you from getting the energy tax credit and tax-exempt financing on the same property. Under the provisions of the Windfall Profits Tax Act, you lose the energy tax credit on that portion of the investment which is financed by "subsidized" financing, which includes tax-exempt financing. The full energy tax credit is lost after December 31, 1982. Until then, transition rules permit a 5% ETC on property financed with industrial development bonds.

Also remember the "public utility property" issue. Public utility property does not qualify for the energy tax credit (with the exception of hydro). Public utility property also falls into a longer depreciation category under the new accelerated cost recovery program.

Accounting. I hesitate to overemphasize the significance of where an obligation appears in a company's financial statements. But accounting treatment is seen as important in many circles, and getting an obligation off balance sheet is often a goal. There are two basic areas of concern in the accounting area. The first is how you can achieve equity accounting, i.e., avoid consolidating project debt and keep it off balance sheet. Solutions to this problem are determined by GAAP principles of consolidation. The second area of concern is embodied in Statement of Financial Accounting Standards No. 47, which deals with disclosure of hell-or-high water purchase agreements. By hell-or-high water I mean agreements to pay for product (steam, electricity, etc.) even if it is not delivered.

Where an obligation resides in your financial statements should not affect in any substantive way your financing decision. But there are times when indenture requirements (e.g. coverage requirements for debt issuance) which incorporate generally accepted accounting principles by reference can pose a real problem, and accounting treatment can become a substantive issue.

Nature of the Facility. As I mentioned earlier, the nature of the particular facility can vary enormously. One question to ask is, who is using the output? Is the steam for a sole user or are there multiple users within steam transmission distance? Can we assume, as is usually the case, that the steam need is continual, not intermittent? As to the electricity, is the entire amount for internal consumption or is there excess capacity available for someone else? That someone else would logically be the local utility, but it might also be another industrial consumer. If you are going to sell to a utility, you may decide to sell only excess capacity or, depending on how the local regulatory authority has implemented PURPA and the level of avoided cost, you may wish to arbitrage. If you arbitrage the full amount, there are some pitfalls for the unwary. One of these is taking the full capacity payment. One thing you do not want to do is sacrifice the insurance factor by contractually dedicating the capacity of your own facility so that it is unavailable to you in the event normal deliveries from the utility supplier are interrupted. There are a number of techniques for coping with this problem.

If the local utility has a low avoided cost, you will at least want to review the wheeling alternatives which may be available to you. You may encounter problems in forcing wheeling, but if you have a cooperative local utility, the option should be explored.

Fuel Source. The fuel source is a critical element. First of all, assuming the present energy tax credit and tax-exempt financing system survives intact, there are some major tax benefits for the right fuel source. Also be sensitive to the problems of preserving the investment tax credit for oil and gas-fired cogeneration. You will want to discuss very early on with tax counsel the investment tax credit and accelerated depreciation implications of oil and gas-fired cogeneration projects.

A second critical aspect of the fuel source is how much you can rely on its availability and what the price will be. Let me illustrate this with two examples. First, a wood waste/coal boiler. If you, the cogenerator, do not control the complete amount of projected waste wood, how do you plan to obtain it and at what price? A boiler that can burn coal also can be flexible to accommodate a shift in fuel supply, but there may be environmental limits on how far the shift can go.

For natural gas, you would want to be sensitive to the availability and pricing policies of the local regulatory authorities. Again, most gas turbine units can burn No. 2 fuel oil, so there is an alternative. Obviously that alternative also places an effective lid on the prices which a gas utility can charge without triggering substitution. However, if gas prices are abnormally low in your particular area, you may face a major increase as prices are decontrolled.

Rating Agencies. Any financial officer is going to be concerned with the reaction of the rating agencies, particularly in the context of whether non-recourse third party financing has any real benefit. Rating agencies will look at each situation on its own merits. But I think it's safe to say that their concern over the risk elements in a project and sources of cash flow are very much the same as yours should be.

Ownership and Financing Alternatives

Direct Ownership.

The simplest mode is the vanilla own it and use it approach. Here the elements I mentioned above are all relevant, but there is nothing on the financing side that gives you any edge in the investment decision. Let's review a few variations on the base case to try to minimize the financial impact.

Tax benefit transfers. To any cogenerator which is unable to take timely advantage of tax credits or is in a low marginal bracket or loss carryforward position, the transfer of tax benefits under the new safe harbor leasing provisions of Section 168(f)(8) of the Internal Revenue Code should be considered. Briefly, you would sell the asset for tax purposes only to a corporation in a higher tax bracket. This is accomplished by payment to you of cash (say 25¢ for each dollar of assets) and a note for the remaining portion of the purchase price. Payments due under the note are matched exactly by payments under a lease to the purchaser of the tax benefits. After the initial cash payment, no money actually changes hands. The lease rent is offset by the note obligations. With the exception of the tax differential between lease payments, which are expensed in full, and income from the note, which reflects only its interest component, the transaction is a wash. The lessee remains the owner of the asset for every purpose other than tax ownership. Interim regulations on this were published several months ago. Predictably, there is now talk of cutting back on the flexibility granted by Congress through the safe harbor leasing provisions.

Tax-exempt financing. Another way to optimize the financing is to take full advantage of tax-exempt financing options. This approach is under attack, is not always available (depending on fuel source, etc.) and can result in loss of energy tax credits, but must be analyzed in each case as to its availability and value. A present value analysis can tell you whether you are better off with the spread between taxable and tax-exempt financing or the tax credit.

Arbitrage under PURPA. The next technique you can use to optimize project economics is to arbitrage electricity sales under PURPA. You may find that PURPA has not been effectively implemented in a particular state or that the avoided cost is too low to make it worth your while. Some companies have decided not to arbitrage as a matter of policy. But you are doing yourself a disservice if you fail to examine this option, and you may be able to work out a very satisfactory relationship with the utility by selling at a price somewhere in between full avoided cost and the industrial rate. Remember if you do decide to arbitrage not to get too greedy for the capacity credits if you can anticipate an electricity curtailment and cannot absorb a loss of electricity for your facility. In short, be judiciously aggressive, but not foolishly greedy.

Non-recourse financing. Lastly, you could seek non-recourse financing for the facility. Even if you could successfully persuade a lender to lend to a separate subsidiary set up solely for the purpose of owning the cogeneration facility and financing non-recourse to the parent, you would still put the debt on your balance sheet under consolidation principles. So most financial officers are not overly intrigued by this option.

Project Financing.

This leads us to project financing. Project financing is a catch all rubric which for this purpose means some sort of third party financing. One traditional method is leasing -- not the tax benefit transfer I mentioned earlier, but the traditional credit lease where the lessor comes up with the entire cost of the asset being leased. With the new leasing provisions of the Economic Recovery Tax Act of 1981, most of the old problems of facilities leasing have disappeared. Nor is residual value any longer a problem, since that requirement has been eliminated. But the lease obligation is still a credit obligation. In the eyes of many analysts, it is a debt equivalent even if it can be kept off balance sheet. Nor is tradional leasing necessary any longer to rationally allocate tax benefits, since the tax benefits themselves can be transferred to corporations who are not otherwise lessors. So let's not forget the credit lease, but let's pass on to other project financing options.

Allow me to take a few moments, albeit belatedly, to establish what I mean by project financing. Much too simply, rather than owning the asset directly and financing it with internally generated capital and funds borrowed by the parent company, a separate entity is established to own and finance the particular asset. Normally, the new entity is a joint venture, in part to share the risks of the project and also the benefits, but also because of one of the goals we discussed above -- equity accounting. Under principles of consolidation, if any partner or shareholder of an entity "controls" the entity, debt of that entity goes on that controlling parent's balance sheet. In a general partnership in which no one partner controls, the debt goes on no one's balance sheet; you make a one line entry to reflect the equity investment and adjust it to reflect the project entity's earnings.

The optimum financing arrangement could be a project partnership which would own and operate the cogeneration project. In an ideal situation, the equipment would be acquired under a lump sum, fixed price, date certain contract with the entire payment on completion. This eliminates financing during construction and any completion risk. The partnership would sell steam to the industrial partner under a long-term take-if-available contract and electricity to the local utility under the same type of arrangement, i.e., a long-term PURPA avoided cost contract to pay for product when available. The partnership would borrow some major percentage of the capital cost from an institutional lender on a long-term, fixed rate basis recourse only to the project itself and the revenues from the sale of steam and electricity. The project revenues would comfortably amortize the debt, and some flexibility would be built into the loan arrangements to accommodate unexpected outages. The lender may well demand an equity participation if the project is attractive. In the perfect world, you -- when I say you, I mean the industrial partner -- might have an option to buy out your partner's interest at some point in the future, e.g., when the project debt has been paid off. In the meantime you would have complete operating control and responsibility under a project management agreement.

If -- and I emphasize if -- this were feasible, you might have the best of all possible worlds. As I mentioned to you at the beginning, look at each structure in light of the various concerns. You would have financed the project without affecting the parent company's financing capability. The debt would not appear on the balance sheet. The partnership structure allows flow through on a timely basis of the tax benefits to the parent participants. A substantial portion of the cash flow to service the debt would come from a third party, the utility. The steam purchase contract is not a full take-or-pay, so you will not be compelled to disclose the contract obligation in your footnotes as a debt equivalent under the FASB's Statement No. 47. Since the debt is non-recourse and much of the cash flow to service it is from the utility, the rating agency view of transaction is likely to be benign.

All the variables I reviewed earlier can be incorporated into this approach. For example, the partners could singly or collectively transfer the tax benefits under the new safe harbor leasing provisions (if these survive).

The critical question is whether lenders could be attracted to lend on such a basis. Obviously the answer revolves around a risk and reward analysis. If you want to attract institutional fixed rate debt in today's competitive capital markets, you are probably going to have to share the rewards of project ownership. Institutional lenders could be the ideal project partner. Other potential partners or owners exist. For example, many engineering firms and equipment manufacturers are helpfully aggressive in providing financing for cogeneration projects. The local utility could also be a partner, although they are likely to have capital constraint problems of their own and with rare exception have generally shown themselves to prefer simply buying electricity, the cost of which is flowed through immediately to their ratepayers under a purchase power adjustment clause. With a finance partner, you are under no constraint to use particular services or equipment, as might be the case if equipment manufacturers were supplying financing. Money is delightfully neutral in this regard. There is no potential interference in project operation as might be the case with a utility which might prefer to operate on an economic dispatch basis. Having a major institutional lender as a partner can help in the negotiating process with the utility and in building a constituency that would have an interest in maintaining the existing deregulated and avoided cost framework.

For projects too small to attract institutional attention, limited partnerships for individual investors may offer some potential, but be careful of the "at risk" limitations in the new tax provisions.

If structured and financed correctly, cogeneration projects instead of being a capital drain could actually be a source of capital.

Institutional lenders which may no longer be interested in lending on any basis to the parent company might be intrigued by opportunities as a lender/equity participant. Cogeneration projects, instead of being a problem, could turn out to be an opportunity.

Conclusion

Third party financing of a cogeneration project is a real option but you will have to integrate carefully all the general concerns I have enumerated today, plus several others that are project specific, into a coherent financing plan. The sooner you begin that analytical process, the more likely you will be to find an innovative solution to the financial constraints impeding the desired development of cogeneration.

We began with history to get an overview of the need to respond to a crisis. Language offers us some insight as well. The Chinese pictogram for the word "crisis" is a combination of the characters for danger and opportunity. Which of those two components dominates depends in large measure on how thoughtfully you approach financing the energy transition.

Mr. SISSINE. Our next speaker will be Roy Leidner. His training was primarily in mechanical engineering, and his experience at Bethlehem Steel has recently involved fuel and utilities concerns. He was appointed director of corporate energy affairs in 1980.

[A biographical sketch of Mr. Leidner follows:]

ROY N. LEIDNER, DIRECTOR, CORPORATE ENERGY AFFAIRS, STEEL OPERATIONS DEPARTMENT, BETHLEHEM STEEL CORP.

A native of Boston, Mr. Leidner holds a bachelor of mechanical engineering degree from Rensselaer Polytechnic Institute.

He joined Bethlehem Steel in 1949 through the company's Loop management training program for college graduates, and was subsequently assigned to the Lackawanna, N.Y., plant. He served in various supervisory positions there before being transferred in 1963 to the project engineering group at the home office to assist in developing plans for the construction of the Burns Harbor, Ind., Plant.

At the Burns Harbor plant in 1966, he was made superintendent of the fuel and utilities department. He was transferred to the home office in Bethlehem, Pa., in June 1973, when he was appointed assistant manager, power and utilities practice and development, steel operations. He was promoted to manager in September 1975. In August 1980, Mr. Leidner was appointed director, corporate energy affairs where he serves as chairman of the corporate energy committee and secretary of the corporate energy policy committee.

Mr. Leidner is a member of the American Iron and Steel Institute, the Association of Iron and Steel Engineers, and is a registered professional engineer in the states of New York, Indiana and Pennsylvania.

STATEMENT OF ROY N. LEIDNER

Mr. **Leidner**. I have some basic points to review, as far as the steel industry is concerned, on what we perceive the Federal role might be.

I want to point out that since the early seventies, Bethlehem Steel has seen their energy costs go from 8 percent up to 20 percent of total operating costs, and that has given everyone in my company, and in the industry, a great deal to think about. So we know all about energy usage, and we are paying attention to it.

I would like to go over some things which we believe stimulate the conservation effort.

As you know, price does. In the real world, since money talks, there are many of us who are very tempted to seek special treatment. This takes the form of targeted incentives, which has encouraged conservation in the past, and will continue to do so. But I want to warn you about the pitfalls that targeted incentives can bring. They do, in our view, create some false signals, which we would like to avoid.

I would like to spend a few minutes on some of the other ways we are approaching conservation in the steel industry. I want to make sure that you understand that we are looking at energy in very broad levels right now. Even within our own company we have an active energy strategy group. What happens 5, to 10, to 20 years from now, is very relevant to the decisions we make today.

We have good intentions, like everyone else on the matter, and we are very highly motivated to conserve, and we do a job at it. We respond to the marketplace and the anxieties that it exhibits.

The near-term motivates our business on a day-to-day basis but the long term is where our energy responses are now being directed. We are going to reduce our costs in energy one way or another.

On the capital side, as far as spending money is concerned, we have several hundred million dollars' worth of energy projects on the books of our corporation. However, the lack of available capital is the problem.

As was pointed out earlier, we test the return on investment on an energy project against other discretionary projects, and it has to stand on its own two feet.

I will say, however, that more and more we are giving consideration to what is happening to the price of energy relative to the price of other commodities. As we look ahead, the cost of fuels are far out racing inflation, and that is tending to bend us in some of our decisions.

Of course, what we do is tied to profitability, and in the steel industry we must see some better days or many of the projects requiring capital will not be installed.

Let's talk a minute about the operating side of our business.

We have a great deal of potential to save energy in our processes.

But we need to change some of our attitudes within the industry to make those changes.

Energy costs are up, and that has management's attention. It is changing their attitudes. As a result, we are in the throes of developing better and more efficient practices in one of our Nation's mature industries. We are energy-intensive and always will be, and at present energy cost levels, the easy conservation actions have been installed.

The tough conservation actions are the ones we are looking at now.

In our own corporation there is a tremendous effort to control energy costs right now.

We have several corporate energy committees. We are spending a great deal of money on training the people within our organization who have their hand on the fuel valve—those who actually decide how much fuel is going into a unit. Also, we are concentrating on the collection of good, reliable data on energy use within our plants.

We are investing money in good metering, good data acquisition, and good data-handling equipment.

The other thing that tends to make us conserve is the threat of a scarce supply.

The best example of energy consciousness that I could come up with occurred in the tough winter of 1976–77, when natural gas was in short supply. In many of our plants, we were faced with the possibility of either letting the buildings cool down and letting the operation keep going, or slowing the operation down to keep the employees warm. When our people were faced with that choice, we saw sweaters, wool hats and gloves come out. People worked in a very cold environment to keep their operation going for several weeks during that winter.

That ethic has been maintained in our employees for two reasons.

One, they are very sensitive about the value of Btu's, and the fact that we must buy Btu's from the OPEC countries is in their minds. Also, they have been forced to pay their own heating bills and fuel their own gasoline engines. Today they are well aware of what energy costs, and this has a very beneficial effect on our corporate conservation effort.

In the matter of scarcity of fuels, we have been forced to install alternative fuel systems, permitting us to keep operating when we have a specific supply problem.

I would like to add a few more thoughts on the conservation effort within a large corporation, which is a particularly complicated process.

Usually there is a time lag between assigning the money and implementing the effort.

It takes a considerable effort to create an environment in which people's attitudes can be changed toward a strong energy conservation ethic.

Let me say that changing the process to pick up a better conservation ethic is more difficult for a piece of equipment that is sitting in a production line than it is for something that just uses energy, like a boiler which serves only energy-related functions.

We have such a complex set of rules for our products today that just telling someone he can heat it a different way or can heat-treat it a different way does not necessarily make it happen. There are metallurgical considerations, and customers to satisfy, so that even minor changes take time.

There are several processes in our business that can only operate using natural gas as a fuel. Because of its cleanliness and our ability to control it, there are few limitations to its use even though another fuel may be more energy-efficient.

How can the Federal role be improved? It is important to understand that today our changes to effect more energy conservation are motivated entirely by economic pressures.

Please don't misinterpret industry's detailed explanations of why it can't do things as a putoff.

The fact is that processes are so highly complex in our industry today that it takes a lot of analysis and a lot of trial to make a significant change—as I mentioned. We must recognize that a time lag is inherent to getting those things done—so I think it is important that the Federal folks be restrained from taking the attitude that nothing is being done out there and that we better do something about it.

A great deal is being done.

I want to point out that the steel industry is highly sophisticated in their analysis of the problems related to energy costs, and it is very aware of its options and is doing something about it.

I have to second Phil's remarks that one of the greatest things that can happen is to succeed in firming up the price of fuels, so we know what they are going to be.

The whole energy structure rests on this price business, and when that settles down, all of us can again take up the very healthy exercise of long-range planning.

If the pricing structure can be stabilized, an important unknown which makes us nervous would be settled out. Additionally, constraining energy prices below their market value, whatever that may be, is detrimental to exploration and to conservation.

A Government concentration on R&D is important, also.

We believe that the market forces will single out the best methods as they are developed, and carry them through demonstration and application phases.

My last point is that the Federal role should include continued educational efforts so we can challenge our citizens to understand the value of a conservation ethic.

A good conservation ethic in this country will fly when everyone understands just what is at stake. When we compare our relatively wasteful ways with the frugality of other nations in their energy use, it appears that they received and acted on the message before we did. Maybe it will take some very dramatic events—price rises, maybe an ice age—but something to instill that sort of ethic into our citizenry. Perhaps the Federal role should help us in that direction. Fuel is precious, and we should recognize it.

Thank you.

Mr. SISSINE. Our next speaker will be Mr. Allen Sheldon. Al trained in chemical engineering and business. His industrial experience has taken him from Procter & Gamble to Alcoa of Australia. More recently he has worked at Alcoa in Pittsburgh, where he became vice president of energy resources in 1975.

[A biographical sketch of Mr. Sheldon follows:]

Aluminum Company of America

Biographical Sketch

ALLEN C. SHELDON
Vice President

Allen C. Sheldon, vice president for Aluminum Company of America was born in Charles City, Iowa, on April 28, 1918.

Mr. Sheldon received a bachelor of science degree in chemical engineering and business from Iowa State University in 1939, and joined Procter & Gamble as a production supervisor. In 1942, he entered the U. S. Air Corps and attained the rank of captain. In 1946, following his discharge, he attended Harvard Graduate School of Business and received a master's degree in business administration in 1947.

After two and one half years with Abbott Laboratories, Mr. Sheldon joined Rea Magnet Wire Company in Fort Wayne, Indiana, as assistant plant manager in 1950. In 1954, he was appointed to Rea's board of directors and became vice president-manufacturing. Mr. Sheldon was named secretary and vice president-operations of Rea in 1958.

In 1960, Rea became a subsidiary of Alcoa and Mr. Sheldon was elected executive vice president, and president in 1965.

The same year, he was named managing director of Alcoa of Australia Limited, headquartered in Melbourne. He was named president of Alcoa Conductor Products Company in Pittsburgh, Pa. in 1968.

On January 1, 1974, Mr. Sheldon became director-energy resources, a position that provided a focus for all of Alcoa's activities in the energy area. One year later, he was elected vice president-energy resources. In August, 1977, he was elected vice president-environment and energy resources. In February, 1980, he relinquished the responsibility for environment and assumed responsibility for defense marketing.

Mr. Sheldon was on the board of the Fort Wayne, Indiana Urban League from 1954-65, vice president in 1961-62, and president 1963-64. He was chairman of the Mayor's Equal Opportunity Council from 1963-65. He was a member of the Parkview Hospital Board from 1954-65 and vice president from 1959-65, and held many other community positions.

In Australia Mr. Sheldon served as a trustee of Latrobe University in Melbourne and as a member of the Australian Fulbright Committee.

Mr. Sheldon is chairman of The Aluminum Association's Energy Committee, a member of the American Chemical Society and chairman of the Materials and Processes Division of the American Defense Preparedness Association.

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STATEMENT OF ALLEN C. SHELDON

Mr. SHELDON. American industry has achieved a commendable track record in conserving energy in the past 8 years. Before the Arab oil embargo, there was little incentive to reduce energy consumption or, put another way, to improve energy efficiency. Until that time, energy was plentiful and cheap. Since then, there has existed a powerful economic incentive for both individuals and industry to conserve.

According to the Department of Energy, there was a 17.7 percent improvement in energy efficiency in the manufacturing sector during the period from 1972 to 1980; 1980 is the last full year of record. In addition, industry's overall share of the country's total energy consumption continues to decline.

Virtually every company today has a formal conservation program in place. Energy management is a priority function. Soaring energy costs, occasional disruptions in energy supplies and cash flow demands make conservation imperative. Capital, technology and management skill have been committed to the task of conserving energy. Government has been helping, too, by funding energy conservation research projects. Alcoa has participated with the Department of Energy in some joint research efforts, some of them Doug Harvey alluded to a few minutes ago.

We feel that the programs were administered well, but the paperwork involved in satisfying reporting requirements has been burdensome. We hope the administration will continue aiding industrial conservation R&D work through the many incentives already available.

A good example of research undertaken jointly by Alcoa and DOE is our inert anode project. We entered into a 5-year, $11 million cooperative agreement to speed up the company's development of an anode that won't be consumed in the cell. A nonconsumable or inert anode would save the aluminum industry tremendous amounts of petroleum coke and energy too. We use one-half pound of petroleum coke for every pound of metal produced. The aluminum industry consumes more than 2.5 million tons of petroleum coke annually. The contract funds from DOE will run out this July, but Alcoa will continue the inert anode program through fiscal year 1982.

The Government has been contributing $1.5 million each year while we've been spending $0.5 million. Even if we could double our own expenditures to a million dollars annually to carry on the work, we would at least double the time needed to complete the project. In selecting projects to fund, we believe that Government support should be given only to those where a high conservation potential exists and where the normal time needed to complete the project would be reduced substantially with Government help. Also, Government support is important in cases where the risk of a project is too great for industry to undertake it alone.

Producing aluminum is both energy intensive and capital intensive. About 70 percent of the energy we consume is electricity, used almost entirely in the smelting process. Thus, aluminum producers have had a historic interest in reducing energy use.

The conventional Hall process for making aluminum—passing on electric current through a molten salt containing alumina—has been around since 1886, and producers have constantly strived to improve it and reduce its energy appetite. We've been able to lower energy consumption from the 1940's, when it took about 10 kilowatt-hours to produce a pound of metal, to an industrywide average today of 7.5 kilowatt-hours. The newest, most efficient cells use just over 6 kilowatt-hours. We expect this trend to continue, although each improvement makes the next one more difficult as we get closer to the theoretical limit of efficiency.

At Alcoa we are continuing to develop an entirely new method of smelting aluminum. The Alcoa smelting process, which is a chloride process, is operating at a developmental level in a new plant in Texas, using just 4.5 kilowatt-hours of electricity per pound of metal produced. Naturally, we hope that the technique will prove to be an economic alternative to the Hall process. It will take many years and huge capital investments, however, before it or any other new smelting technology could possibly replace the Hall process plants currently installed.

We were working on another smelting method called direct reduction jointly with DOE. This process involved producing aluminum in a blast furnace—a technique similar to that used in the steel industry and altogether unlike the electrolytic reduction technology we are now using. But we encountered several technical problems and the whole approach has proved to be uneconomical so it has been dropped.

We are doing paper studies of a plasma arc process instead, but Alcoa cannot invest R&D money in this research just now. DOE has expressed interest in this alternative method and would consider helping, if it has the funds to do so. We are not sure they would have the funds available to pursue it.

Many other projects are underway in our research laboratories, especially to improve the Hall process. Some of them require costly investments over long periods of time, like the inert anode effort. The industry's cash flow is too low—in some cases, it's negative—to sustain all of the R&D work we would like to pursue. Still, Alcoa is planning to spend $92 million on R&D this year, and we spent $87 million in 1981. Last year, 27 percent of our R&D projects were devoted to energy saving efforts, or almost $24 million. This year we have earmarked slightly over $30 million, or 23 percent, of the R&D budget to energy-related projects. Since our process is so energy intensive, almost any process improvement saves energy.

In 1981 Alcoa's capital expenditures totaled $678 million. Of that, about $152 million was spent to improve energy efficiency in one way or another. Total expenditures will be trimmed, however, in 1982. The money squeeze inhibits our ability to invest all that we would like to in new energy-saving equipment. A good example is an improved ring baking furnace that we have developed for baking the carbon anodes which are required in our prebake Hall cells. We use a lot of energy to mix petroleum coke and coal tar pitch to form and bake green anodes, and cast metal electrical connections into the anode sockets. The bulk of the energy consumed is used in the baking stage.

With a new furnace design we have developed through computer analysis, we can cut present fuel use in the baking operation by 60 percent. That is an outstanding return on the investment. Yet each furnace costs $18 million to $30 million. We have replaced 4 furnaces, but we have 18 more we would like to replace. We do not have enough money, even though energy efficiency would go up by 60 percent and consumption of natural gas would decline by billions of Btu's. The investment is simply beyond our present means.

Beyond smelting, all aluminum producers have energy-saving projects either completed or contemplated to stretch fuel supplies and fight rising energy costs. A major effort is the installation of recovery systems to allow the use of waste heat from smelting furnaces. Since 1976, we have installed 13 recuperators and 9 more are planned. There is a sizable capital requirement for installing recuperators.

We recently installed a silicon carbide tube and shell type convection unit on a melting furnace at our Davenport Works that we believe is the state of the art in recuperation. It is like the one that Doug Harvey was discussing a few minutes ago. It cost $800,000. We are evaluating its operation now, so final numbers are not in yet, but we see a potential for fuel savings of 37 percent. We have already installed air curtain dampers on all 90 of the company's holding furnaces, which has cut our gas consumption by about 17 percent in those furnaces.

Alcoa has begun a sizable investment program to install continuous strip casters that could save up to 50 percent of the energy used in the conventional rolling process. Strip casting eliminates ingot casting, scalping, preheating, and hot rolling. We can produce coiled reroll directly from molten metal. Four continuous casters have been installed at two Alcoa plants. They are not all operating yet. But for the product involved so far, we are getting a 20 percent fuel savings with the strip caster.

I won't go on and on listing the multitude of energy-saving projects aluminum producers are carrying out. But I will mention one major, successful project unique to aluminum in its potential for saving energy. That is recycling. You may know that by recycling we save 95 percent of the energy required to produce aluminum from the ore. Last year Alcoa recycled 12.6 billion used aluminum beverage cans. Those cans provided 528 million pounds of aluminum that we did not have to produce as virgin metal. The entire industry recycled 22 billion cans, which provided 950 million pounds of metal.

Further, using more aluminum in automobiles and then recycling that metal will help the country save energy. Aluminum provides an automobile with weight reduction and fuel savings. The aluminum industry conducted a study of highway transportation vehicles that spanned 1972 through 1980. It compared the total lifetime energy savings for such vehicles produced in a given year to the energy needed to make all aluminum in the United States that year.

To calculate total energy savings, data was obtained on the average miles driven in a car's lifetime, assumed to be 100,000 miles, the average number of pounds of aluminum in the cars of each model year, and the number of cars produced each year. Similar calculations of energy savings with aluminum were made for trucks, buses, and trailers. The lifetime energy savings using aluminum exceeded the energy needed to produce all aluminum each year 1977 through 1979. The savings will be even more striking when aluminum in vehicles is recycled. Unfortunately, the production of vehicles dropped off dramatically in 1980 and 1981 so a similar comparison wasn't considered valid. We expect the savings to hold true when production levels in Detroit go up again. But that's another speech.

Let me end this one by repeating that energy conservation in industry is working. It is, in fact, vital to energy-intensive companies. I believe our significant success in reducing energy consumption in the aluminum industry reflects our commitment to conservation.

In 1974, aluminum producers pledged to reduce energy use by 10 percent per pound of production by 1980. The base year is 1972. That goal was met in 1978. Producers then doubled the goal, pledging another 10 percent reduction by 1985. That means we intend to produce aluminum in 1985 with 20 percent less energy than we used in 1972.

It is kind of hard for me to be on panels where some companies' speakers are saying they saved 48 to 60 percent. We have been working on conservation from the very beginning. Generally, those companies talk about saving a few billion Btu's per year. Our industry, in the first 6 months of 1981, saved more than 92 trillion Btu's, equal to about 700 million gallons of gasoline, or enough to propel 2.4 million cars during that 6-month time period. And on an annualized basis, that is 180 trillion Btu's per year. There is a potential for further energy reduction, but we are being hindered by cash flow problems. We are spending all the money we can afford on conservation. If we had more capital to invest, we would use it.

Conservation is not without its problems, however. The electric utilities, for example, are having to adjust to slower growth. They are having to adjust to a new operating environment and conditions unfamiliar to them. Where aluminum smelting plants operate, they usually provide the utility with a secure base load. Smelters need electricity year-round, 24 hours a day, 365 days of the year. At least part of their power is interruptible, however, so that the utilities can use us for their spinning reserve. In so doing we subsidize other customers of electricity.

We are concerned that as we increase our conservation, reduce our power requirements, the utilities are going to have to increase rates to their other customers because our base load will be going down. In this period of transition where they are having a lot of other problems, we are concerned that this will add greatly to those they already have.

In addition, we will need large blocks of electric energy in the future at affordable prices in order to continue our growth. Where that growth will occur will largely be determined by the availability of power and its cost, whether it is in this country or abroad.

I would like to take 2 more minutes and run quickly through some slides that I have. I have some slides here of the equipment that we discussed to show you that there is reality in what I am saying.

This [referring to slides] is a typical aluminum pot line in 1914. At that time, of course, Alcoa was the only producer. The rods you see are sticking down in a bath of cryolyte, sodium aluminum floride. This is about 1920. These pots were designed in about 1932 and installed. This is a similar pot to the last, only it has been covered. Alcoa was very conscious of environmental problems way back in 1952, and we were able to effectively remove the floride fumes through this process. This was a pot line installed in about 1947.

This is the state of the art in the early 1960's. And this is the current state of the art. This potline is half a mile long. You can stand at one end and see a dime drop at the other end because the air is so clear. That is very unusual in our industry.

This is another picture of that same pot line.

This is our chlorine process. We go from bauxite through a chemical reactor, chlorinate the alumina to aluminum chloride, which then in turn goes through the electrolytic cell, produces primary aluminum and chlorine which is recirculated.

This is a picture of the plant. It is a very large developmental plant in Texas.

This is the principal of the cell. This one generates about 4.5 kilowatts per hour per pound of metal produced. These are the anodes used in the process, these the baking furnaces I was describing where we are saving 60 percent. This is an old baking furnace. This is the new design.

This is a typical heat recuperator on a melting furnace. This is typical recuperator installation; this is a sketch of the air curtain damper where you use the air normally going into the gas burner to blow across the top of what you might call the chimney on the furnace just like you use on a department store front door to hold the heat in.

This is a direct caster of aluminum from metal to sheet. Another picture. This makes quarter-inch sheet. This is our can scrap. This is the way the cans come back from all over the country. They are fed in and chopped up and go into a smelting furnace. This is the aluminum industry voluntary industrial energy conservation program which we started in 1974. We are well on our way to our goal.

Mr. **Sissine**. We will have to close this part now.

Thank you.

Before we open the session to questions and answers from the audience, I would like to ask the panelists if they might like to comment on each other's presentation. In order to kick off this session, we might throw out the question: How do you make a decision whether to fund the conservation project in-house or to seek Federal assistance with it?

Anybody may start.

Mr. **Sheldon**. I can tell you how we do it within our firm.

If we figure we can do a project in a reasonable period of time, we will do it with our own funds to keep it proprietary. If we feel that it is going to take us 10 to 15 years to do a project, then we seek government help, try to speed up the activity. It is more a matter of the amount of speed-up than it is of whether we will do it or not. We will do it eventually.

Mr. **Leidner**. Speaking for our firm, I think, philosophically, if we have to seek Government help for it, it is not a good idea in the first place. We believe a process should stand on its own two feet and, that is the only way it can work effectively.

Mr. **Huyck**. I will make a comment, not being involved with the industrial process directly, and therefore having no responsibility for it.

There are two categories of activity that the Government undertakes. One is active involvement, funding, and encouragment, through various types of direct funding incentives, of conservation analysis. The other role is to establish a regulatory incentive framework that allows the market forces to work, and allows new players to get into the game or new trends to occur. It is the latter area where we see perhaps the most significant role.

There is only so much you can do in the first category, and because of the extra burden and extra weight that comes from any additional player in the game, I do not care whether it is a joint venture partner or the Government, any time you add another player you get exponential difficulty in getting the job accomplished.

As you think of conservation, after a point you have squeezed the system for efficiency and you begin to come down the curve. Your question then becomes increasingly: How are you going to produce energy efficiently?

It is in the latter category that you begin to look at financing projects and opening up the ownership of those projects to new participants where I think the Government has a major role to play. But it is clearing away the terrain as opposed to eliminating an active player.

Mr. **Harvey**. I think my comments are primarily related to the economic incentive for private industry to invest in either advanced unproven technology or in existing technology. Throughout industry, I believe the financial incentive has to be there. I noticed that this was expressed by most of the panelists here this morning. That is, that the potential for return on investment has to be there in order to justify the project. However, the return on investment for best-available technologies is seriously eroded by the recent increase in the discount rate for individual corporations. Furthermore, even the perception of increasing costs for money is a serious deterrent to industrial investment in new or proven technology.

In the advanced technology area, I do not think the free marketplace works at all, because I do not believe that the foreign governments which are involved in their industrial programs are operating under the same ground rules.

The Swedes are putting 50 percent into a new process that is being developed for the pulp and paper industry for pyrolysis of black liquor. Henri-Claude Bailly will discuss a number of projects being undertaken jointly by foreign governments and their industries that indeed represent severe competition for advanced process technology.

So the U.S. primary industries are playing catch-up ball essentially on a constant basis. Best-available technology in the textile industry traditionally comes from Switzerland and Italy. This is a major problem. I do not see why this country should be playing catch-up ball.

Mr. SHELDON. The aluminum industry is the exception.

Mr. HARVEY. You are right.

Mr. SHELDON. We are still the state of the art in the world.

Mr. HARVEY. No question, the U.S. aluminum industry is probably the most sophisticated aluminum industry in the world.

Mr. SISSINE. Any other comments, panelists?

Before I open up the questioning, I would like to mention that there are some panelists in attendance in the audience who will be participating in later sessions and I would like to encourage them to offer questions at this time also.

Would you please identify yourself first?

Mr. BRADY. I want to direct my question to Mr. Sheldon.

I would like to refer back to an excruciating example of yours of the tremendous savings that could be achieved in the ovens if you had the capital available. If it is so critical a national matter that you save that amount of energy, you could project its value to the Nation if it were otherwise consumed as imported oil, imported gas, and so on. What has happened to your decisionmaking as a result of the Reagan tax package, and what would it take to push you into making the decisions on the remaining 16 ovens?

Mr. SHELDON. The first constraint on the tax package is that you have to have profit to cover whatever you are going to deduct. We are very close on that this year; last year, in 1981, and probably in 1982 also. So that is our first problem.

The second constraint is, that our board of directors wisely limits the amount of outside debt that we can handle. We think that is proper.

So between these two constraints is sort of where we are ending up right now. We just do not have the cash flow to handle that sort of thing.

Mr. BRADY. Tax credits are not sufficient to push you over the line, the sale of tax credits is, if you were not profitable——

Mr. SHELDON. We do not have any to sell, that is the problem. We do not think you can get a high enough return to do that. We talked about this before, you and I. We do not think we can get a high enough return for this type of project to make it practical.

Mr. STEINWAY. I would like to followup on that question.

What impact do you think the R&D tax credit will have on some of the decisions that your companies will be making and how effective have the business conservation tax credits been today in terms of the activities that Alcoa and others may have tried to undertake, the business tax credits from the Windfall Profit Tax Act and the R&D tax credits?

Mr. HUYCK. For which the regulations just came out.

Mr. SHELDON. When you write a law like that and leave it up to IRS to define it and they never do, what good does it do you?

Mr. HUYCK. They will expire.

Mr. SHELDON. It runs out at the end of this year?

Mr. HUYCK. That is the lag I was talking about.

Mr. STEINWAY. What about the R&D tax credits? I do not know if it was Alcoa that talked about the increase in R&D expenditures you are doing in-house. Do you think they will be helpful?

Mr. **Sheldon**. It will be helpful but it won't be tremendously helpful.

Mr. **Leidner**. I do not have a fix on that. I am sure it will be helpful, but I do not know how much.

Mr. **Sissine**. Other questions?

Dr. **Frankel**. Doug Harvey and Mr. Huyck, you seemed to indicate that the negative impact of the rising interest rates on the one hand, and the change in PURPA policy and possibly elimination of tax credits on the other hand, may create fluctuations in overall financial conditions, which outweigh the benfits of the Economic Recovery Tax Act. Is that a fair characterization of your position? Could ERTA erode the benefits to the point where they are practically nonexistent?

Mr. **Harvey**. The calculations that I did indicate that if you had a 20-percent investment tax credit and a 5-year depreciation, the acceleration of investment in best-available technology would be 20 percent. In other words, if a company were expending $100,000 on new equipment, they would be willing to increase it to $120,000. If during this same time period the discount rate increases 2 points, that cuts the acceleration in half. In other words, they would be willing to expend only $110,000.

If you take away the extra 10-percent investment tax credit, that would only accelerate the investment with the 2-point increase in discount rate to 3 percent. So it is a variability between 20 percent acceleration of investment to 3 percent acceleration.

Mr. **Huyck**. I have not attempted to quantify for you because the impact of inflation, as reflected in interest rates that feedback on corporate decisions, is a complex phenomenon. What happens in terms of corporations' ability to raise debt in the capital markets? They have in their indenture and loan agreement certain coverage requirements on their income which apply to the interest that they have to pay.

It is a system imbedded in corporate America. The rating agencies, their rating systems, the ability to raise debt, and the ability to function in capital markets is founded on a system that reflects the way our capital market existed over the past 50 or 60 years. But with very high interest rates, every time you issue debt, you accelerate the deterioration of your coverage ratios. So it is not just the ability of the capital markets to supply that debt, but also the fact that your system is founded on a much lower inflation rate which establishes the infrastructure, financial, the indenture infrastructure on a much lower rate of inflation and results in an enormously disproportionate impact of issuing debt at very high levels.

There is a great deterrent to companies not to issue debt for whatever purpose. This means that they are back to internal generation and low profits translate into cutbacks in capital expenditure program budgets. As a result, you get a static or shrinking pie in terms of capital available, and you also get the kinds of conflicts in investment decisions we are talking about here.

You can focus on that battle, on how to encourage them to spend more money, or on how to give them more income by accelerated depreciation, which is nothing more than trying to eliminate bracket creep for corporations.

By giving them accelerated depreciation, all you do is put them back where they should have been if you did not have that kind of inflationary system in the first place. It is not extra. It is trying to rectify the balance.

The other question, is there any way you can go outside for sources of capital? You are getting a lot of apples and oranges in perspective here.

Is there any place else you can go for available capital that does not impact them in the traditional manner? That is what the financial world is trying to come up with.

If the rules of the game have changed, is there any way that you can cope with that? Can you come up with new financing techniques that do not result in a direct hit against the parent company's credit, and are not included in that system? What about the kind of financing that goes under the rubric of project financing or third-party or nonrecourse? Is this the kind of effort which is needed?

This kind of thinking is quite different from the kind of thing we are talking about in the normal internal analysis. I just wanted to reflect that.

Mr. **Sissine**. Further questions?

Mr. **Sheahen**. We have done a certain amount of analysis—and to some extent sensitivity analysis—of investments under scenarios in which you cannot raise your profit, your price very high or where your dreams do not come true as far as how much energy you save in a certain project.

We found that these uncertainties, things that you cannot be sure of, absolutely outweigh things like tax credits and so forth. The idea that the inflation rate and therefore the floating interest rate could jump on you out in the middle of an investment to us seems terribly frightening in terms of how it shifts the ROI.

Therefore, seeing this ahead of time, the corporate investors would postpone or decline to invest. I wonder if our panelists could answer, from their experience, whether this same kind of thing keeps showing up?

Mr. **Leidner**. The answer is yes.

We were talking about a stable foundation before—this situation of not knowing and not being able to comment—is what stops things cold, as Phil indicated. Yes, it is an area in which we could surely use some help.

Mr. **Huyck**. You are describing the same problem in a different way, the blind men and the elephant. You have your limb and that is all you feel. Interest rates are one symptom of a high inflationary situation.

Industry is unable to raise its prices, and the utilities have their political constraints. Due to these conditions, neither sector can get a revenue stream which reflects their inflated costs. One difficulty is on the cost side and one on the income side, but they are both manifestations of the same problem. The net result is a squeeze, a reduction of capital expenditures for any investment.

Mr. **Sheldon**. In such a situation, you can try to help yourself through R&D—if you can demonstrate these things without too much expense. That is, if you know what your risks are when you are going out into a plant environment, you are a lot better off. That is what we try to do.

Mr. **Sissine**. Further questions?

Mr. **Gelb**. Bernard Gelb.

A question regarding the Federal role in industrial energy conservation with respect to the tendency of industry to look toward the location of plants outside the country, if they think energy costs might be lower. There may be, in a sense, some national or social benefits to be gained by having the Federal Government assist with energy conservation in order to curb this tendency.

I would appreciate it if the panelists would comment on this idea.

Mr. **Sheldon**. I will be glad to.

We are a living example. We are expanding rapidly in Australia and Brazil because electric power costs are so much lower in those two areas. The potential for increasingly lower costs is present in those two countries whereas it is not in this country.

Mr. **Gelb**. In this context, would you see any advantage to the Federal Government helping you to lower your domestic energy costs? Or do you think it is a hopeless case?

Mr. **Sheldon**. I was talking about the impact we are having on utilities by doing that, taking away their base load and so on. We are experiencing the opposite. Examples of the current experience include the Northwest power bill, renegotiation of PASNY rates, renegotiation of TVA rates, cost of building a powerplant, and the indefiniteness of even trying to build a coal plant.

We generate between 50 and 55 percent of our own power. If we—unfortunately, we are not—if we were a utility we would be about the 28th largest in the country. So we have a pretty good idea of what the power costs are. We just plain cannot compete in this country any more.

For example, the world price of aluminum—the published price—is 76 cents per pound. It is actually selling for 52 cents. The Japanese power cost alone is over 40 cents. You figure 7.5 kilowatt-hours per pound, and go backwards to what you think the kilowatt-hour is worth. Out in the Northwest, we are escalating up to 3.5 cents per kilowatt-hour. Multiply that by 7.5, and you are almost halfway to the current price of the metal. We cannot compete on such a basis.

Mr. **Sissine**. Would another panelist like to comment?

Mr. **Harvey**. I would.

There are several reasons for exporting our basic industries overseas. One is the competitive cost of fuels. The aluminum industry, for example, is currently paying about 14 cents per pound of metal for electricity costs alone, whereas Canada was producing aluminum for 5 cents per pound. The aluminum industry, facing renegotiation of electric rates, obviously has to look for lower cost electricity. Brazil and Australia offer such opportunities.

The reason for incursion of foreign steel in this country is the fact that the U.S. steel industry has to compete with Japanese and Germans who have been dumping their products into our domestic markets. As a result, the U.S. steel industry is exporting its capability overseas. They are not building plants overseas, but overseas competition is taking over the U.S. marketplace for steel.

We have tremendous indigenous wood supplies in this country, which is going to support the pulp and paper industry in this country for a long period of time. However, the new technologies that the Swedes and Finns are introducing into the paper industry are going to create a severe competitive problem for U.S. producers.

The same is true in every basic industry. I hate to think of the United States being only a high technology country, where genetics and computer technology seem to be the only industries in which we maintain a strong position. It is hard to conceive of a secure defense industry without domestic steel and aluminum production.

Mr. LEIDNER. I certainly won't argue with those comments. However, I would say that foreign competition may not be so much of a threat because we have ample coal resources. Additionally, because the Japanese Government-steel industry relationship is entirely different from ours, it does cause problems in other directions.

Mr. HUYCK. We are dealing with a number of clients looking at the possibility of shutting down marginal facilities and refineries. A series of other investments that have become marginal, are getting more so, and will go out into the red zone in the near future due to increased energy costs.

They have the choice of making capital investment to retool that infrastructure to make it competitive or shutting it down. Whether that goes for investments abroad, I cannot anticipate. But that is an existing investment which may be eliminated—as opposed to looking de novo at an investment opportunity, and assessing how it would affect the decision on where to make that investment.

Mr. GELB. So I infer from your collective response that you really did not—either I stated my question poorly or whatever—that you do not see a place for the Federal Government to try to take steps to slow down or prevent the kind of relocation you have all described in various respects?

Mr. SHELDON. I think it is completely impossible.

Mr. HUYCK. It may be a little bit like King Canute, the tide is going to move—the question is how you accommodate to it, not how you stop it.

Mr. LAWRENCE. Could I ask Mr. Sheldon and Mr. Leidner, without giving away corporate information in the steel and aluminum industries, would you describe the time frame you are looking at for return on investment into an energy improvement capitalization?

Mr. HUYCK. Payback period?

Mr. LEIDNER. I have to say that question is a little bit academic when we must look so hard for what discretionary money we have. We like to say 1 to 3 years.

Mr. SHELDON. Most of the projects you talked about this morning involve about 2½ years.

Dr. FRANKEL. Doug, when you were reviewing the introduction of new processes in steel and other industries, were they developed with government assistance to these countries or largely through private-sector financing?

Mr. HARVEY. It is hard to define government assistance. I do not know what government assistance means for Japan. However, I do know that the Japan Development Bank loans money at interest rates that are extremely low. The interest rate in Japan itself is extremely low, but the Japan Development Bank, which is a Japanese Federal Government entity, loans money to the steel industry at something like 5.5 percent.

So the availability of capital for best available technology or new technology research and development is a hell of a lot higher than it is in this country.

When our steel industry is paying 16 to 18 percent for money—even for nondiscretionary money—there is very little room for improvement. Would you agree with that?

Mr. LEIDNER. Absolutely.

Mr. SHELDON. I might go one step further than that; you have to do business in Japan to appreciate how far they go. When I was in Australia, we were going to start a project to develop a smelter through funds loaned from Japan for a long-term contract. However, this occurred at the time that the Johnson administration stopped the outflow of funds from this country which, in turn, stopped the outflow of funds from Japan. We got the Japanese to give us the equivalent in equipment. They were so anxious to export that they gave us the dollars and the equipment.

This country would not think that way, nor could it. The Japanese were able to make that decision in about 2 years.

Mr. HARVEY. The Saudi Government is offering a 3½-percent loan of $3 billion, to construct an olefin plant for natural gas conversion to ethylene. That is going to place our olefin industry in extreme competition.

Mr. SHELDON. It is a whole different world; we are dealing in a nonfree market.

Ms. GINN. If we were to assume a Federal R&D program in industrial conservation, would each of the panelists agree on the criteria or the process by which those various projects should be selected? I know we had a program in the past.

What I am asking is, have we been using an appropriate selection process—or is there something else we should be looking at?

Mr. HARVEY. Can I comment on that?

Clearly the Federal Government should not be funding projects that are in competition with things that the private sector is doing itself. That should be the first criteria.

Now that is not an easy thing to determine, however. You have to be pretty careful about assuring that the risk associated with the project is sufficiently high that the probability of some corporations doing the same thing on their own is small.

The technique that was developed for evaluating this factor is somewhat circumspect. The National Materials Advisory Board issued a report in which the primary criticism was related to the method of evaluating the probability of failure of different projects. That is why I used the discussion matrix in my evaluation, as opposed to a numerical scoring technique. Admittedly, it is a very difficult problem. But one thing is clear. You should be funding programs that are near enough to fruition such that they can assist our industry.

I really do not believe that the way-out research programs are going to have sufficient impact on industrial energy productivity in the near term, say the next 10 years. Furthermore, the probability of failure for these programs is probably 99 percent.

In the same article that Myers and Sweezly discussed innovation failure, they estimated the probability of failure from an invention. This project had not entered the laboratory phase, much less the prototype or the full-scale demonstration phase. The probability of failure was estimated to be 99 percent. Now you are going to have to fund an awful lot of such projects before they are ever going to make an impact on industrial productivity.

On the other hand, if you are only funding these high-risk projects, let's say that have a 50-percent probability of failure, then you are likely to be competing with the private sector. That is a difficult thing to establish, but I think the technology, the methodology currently being used is about as good as you can do.

I know of one error that we made when I was part of that program. It involved the funding of a project in which private work was going on. We were not aware of it. The companies came in very rapidly and told us about it.

Mr. **Leidner**. I think you should ask somebody and get some industrial input as far as the energy projects are concerned, so that kind of surprise does not show up.

Mr. **Sissine**. Further comments?

If there are no more questions, then we will conclude the first panel.

I would like to remind everybody that our second panel on energy conversion equipment will commence at 11 and the panel on policies and programs will begin at 2.

I would like to thank our panelists for a very enlightening discussion and thank the audience for their questions.

We will take about a 15-minute break now.

[Recess.]

ENERGY CONVERSION EQUIPMENT

STATEMENTS OF DR. DONALD W. COLLIER, SENIOR VICE PRESIDENT FOR CORPORATE STRATEGY, BORG-WARNER CORP.; FRANK R. L. DALEY, DIRECTOR OF ENERGY MANAGEMENT AND PLANT ENGINEERING, GENERAL MOTORS CORP.; MAURY GAMZE, VICE PRESIDENT, GAMZE-KOROBKIN-CALOGER, INC.; GEORGE F. MECHLIN, VICE PRESIDENT FOR RESEARCH AND DEVELOPMENT, WESTINGHOUSE ELECTRIC CORP.; AND STANLEY W. SCHROEDER, GENERAL COUNSEL AND DIRECTOR OF LEGISLATIVE SERVICES, GAS APPLIANCE MANUFACTURERS ASSOCIATION, INC.

Dr. **Crane**. Our second panel discussion will be on energy conversion equipment.

Our first speaker will be Dr. Donald Collier, senior vice president for corporate strategy, Borg-Warner Corp.

[A biographical sketch of Dr. Collier follows:]

From: Carl Byoir & Associates, Inc.
200 S. Michigan Ave.
Chicago, IL 60604
(312) 322-8676

BIOGRAPHICAL INFORMATION

For: BORG-WARNER CORPORATION

DONALD W. COLLIER
Senior Vice President--In Charge of
Corporate Strategy
Borg-Warner Corporation

Donald W. Collier was elected senior vice president, in charge of corporate strategy for Borg-Warner Corporation in April, 1978. He had been vice president--technology since 1975, and before that, vice president--research since he had joined the company in 1960.

Collier's duties include counseling management on corporatewide technology, strategic planning and corporate development. He also is chairman of the corporate planning committee's development council, an advisory group on business strategies.

Before joining Borg-Warner, he was president of McGraw-Edison Company's Thomas A. Edison Research Laboratory, West Orange, N.J. Collier was a chemical engineer and a research chemist for Sharples Corporation, Philadelphia, from 1944 to 1951; he worked on the Manhattan project 1944 and 1945.

Collier was a member ('73-'81) of the technical advisory board of the United States Department of Commerce and is a fellow of the American Institute of Chemical Engineers. He was chairman of the Directors of Industrial Research from 1977-1978, and has served as president of the Industrial Research Institute, Inc.

He is a member of the American Association for the Advancement of Science, the American Chemical Society, the Research Directors Association of Chicago, the Association of Research Directors of New York City, Sigma Xi and Phi Eta Sigma.

Collier also was chairman of the advisory council to the polymer materials program at Princeton University, Princenton, N.J., where he received a master's degree in chemical engineering and a doctorate in phyiscal chemistry, both in 1944. He received a bachelor's degree, summa cum laude, in applied chemistry from Catholic University of America, Washington, D.C., in 1941.

He is a member of the Cliff Dwellers Club and has been a subscriber to the Chicago Symphony Orchestra for 17 years. In his leisure time, he enjoys piloting a sailboat on Lake Michigan and skiing the Rockies around Vail, Colo. and Salt Lake City.

Collier, who was born June 5, 1920 in Washington, D.C., lives in Chicago.

STATEMENT OF DR. DONALD W. COLLIER

Dr. COLLIER. Thanks, Langdon.

As Langdon said, I am senior vice president, corporate strategy for the Borg-Warner Corp. and previously was its vice president, technology.

Borg-Warner is a highly diverse company and makes several kinds of equipment that are related to energy conversion. Our York division produces heating, ventilating, and air-conditioning equipment and has recently introduced new air-conditioning systems which save up to 30 percent of the energy used by conventional systems.

Our Byron Jackson division produces pumps, valves, and seals used in the electric generating industry and in the petroleum production and refining industry. Our Morse Chain division produces a variety of industrial and automotive drives, and, finally, a product that we are probably most widely known for—the automatic transmission—which is also an energy conversion device.

In preparing my remarks, I have assumed that the energy conversion equipment that we are discussing is that which will be used in the civilian economy—rather than for defense and specialized government use. Therefore, the vehicle which will produce and distribute this equipment to the civilian economy is private industry.

Past Federal activity in this field has involved research, development, and demonstration programs for such devices or to provide tax incentives for their installation. I will direct most of my remarks to the former program, but touch on the latter in closing.

If the delivery vehicle for energy conversion equipment to the civilian economy is private industry, the question naturally arises—why should Government do or support R&D in this field at all? Shouldn't the producing industry have enough profit incentive to do the necessary R&D itself? I think the answer to this last question generally is "yes." Thus, the quick answer to the first question is that the Government should not be involved in R&D in this field. However, I believe that is a bit too easy a response.

Because of the importance of energy production and conservation to our national goal of increasing productivity, as well as to our national security in terms of dependence upon foreign oil sources, I can identify at least one situation in which limited Government involvement in R&D in this area is justified—but with some reservations I will discuss later. That situation is where the research and development would be useful if it is successful technologically, but is of such high risk that it would be unlikely that any single firm would undertake it. By having the Government undertake or support the research, the risk is then spread over the entire economy. It is possible that we might miss some major breakthroughs requiring high technological risk unless the Government, in effect, becomes the insurer of that risk.

Now, my reservations: Successful R&D is only the starting point of innovation, and the economy is not helped until successful innovation occurs. I define technological innovation as the creation of an invention or idea and its application in the economy; that is, until the results of the R&D are distributed to the users in the economy in the form of usable products or services in a cost-effective manner, the country does not benefit.

Let us bear in mind that the Government is notoriously unsuccessful when it undertakes applied projects aimed at the civilian economy. Only a small fraction of the Government-owned patents are applied commercially. An understanding of why this is so will lay the basis for a proposal I would like to make that may improve this situation.

Those of us in industry whose jobs depend upon our creating successful technological innovation have learned the hard way that there are three basic principles that must be adhered to. They are, if I can underline this with the slides:

First, there must be a tight and responsive link between the potential users of the technology and the generators of the technology. Innovation is a highly iterative process in which the potential users and the generators influence each other to mold the development into its finally successful outcome. I am sure all of you have heard the old saw about—"Boss, I've got a great dog food—the only trouble is that the dogs don't like it."

Second, the business system in which the invention is to operate should be developed contemporaneously with the invention. Again, innovation does not succeed until the item is delivered into the economy. Unless the business system and the invention are compatible, delivery does not occur.

Third, the best technology transfer agent for commercialization of an invention is the group of people who developed the technology. The worst is a research report. Those of us who have been through the mill of trying to get something out of the laboratory through the manufacturing department and into the marketplace know that this is where most of the hangups occur in innovation. Without a dedicated and knowledgeable group of people to help get the project over the many hurdles it will encounter, it will usually die someplace along the line. It is virtually impossible to incorporate everything that the R&D people have absorbed through their pores in a research report, and, if it were, nobody would read it.

To the extent that these principles are violated, the probability of success with innovation diminishes.

Applying these principles to Government research aimed at the civilian sector whether done in Government laboratories or supported in universities or research institutes, makes it very apparent why the success rate is virtually zero. Every one of the principles is extensively violated.

This would lead one to the conclusion that the most effective way for the Government to support high-risk R&D would be to select the company that has the best capability of commercializing the result, support them during the research and give them exclusive rights to the results of it. You see that working in the process industries where their know-how almost gives them an exclusive jump, but we are talking about products that will be sold broadly. When you do that, this obviously has political problems.

The use of tax money to provide a private company with a competitive advantage is politically untenable. It is the principle that "what the taxpayer pays for should be available to everyone" which led to that pile of unused Government patents. An invention that does not get utilized in the economy brings no benefit to any taxpayer. How do we get around this dilemma?

Let us assume that the research project that we are talking about is useful if successful technologically, but of high risk technologically. A Government agency wants to carry out such research either in their own laboratory or at a university or a research institute. It will write up the project as a research proposal describing the approach, what it would cost, how long it would take, and what the expected result would be if it is technologically successful.

A specific example might be a project to develop a more efficient photovoltaic converter by investigating a new class of compounds that have not been explored before. An expectancy might be that this converter would have a 25-percent higher efficiency than anything currently on the market and would not be more than 10 percent more expensive to produce.

The research project writeup is published in the Federal Register and copies of it mailed to all potentially interested industrial companies. The Government would then take competitive bids from all potentially interested companies for exclusive rights to the results of this research if it were to become successful. We have a precedent for this sort of thing in the Government's taking bids for oil leases.

The bids would be in the form of a relatively nominal up-front payment plus a royalty—minimum and running—if the project met its technological objectives. The successful bidder would, of course, be under no obligation to pay the royalties if the project did not meet the spelled-out technological objectives—although he would have the option to use his judgment for intermediate cases.

If the successful bidder rejected the terms on the basis that it had not met the objectives, the Government could then put the completed project out for competitive bids if it felt there were some commercial value to it, even though it had fallen short of the original objectives.

Unless the Government receives suitable bids from the initial offering—that is, bids that would at least return the cost of doing the research to the Government if it were successful—the project would not be undertaken. Thus, we have put a market mechanism into the selection of projects supported by the Government.

The successful bidder has an incentive to work with the Government laboratory to try to make the project as successful as possible. He already has some of his own money invested in it in the downpayment. His bid, made under the assumption of technological success, is economically attractive to him. The Government-supported laboratory and the contractor already committed to an exclusive arrangement, would have no inhibitions against working as closely as possible with each other during the progress of the project.

Since the successful bidder is the potential user of the technology and the Government-supported laboratory the producer of same, principle No. 1 for successful innovation is accomplished. If the project begins to look favorable, principle No. 2 is also accomplished, since the successful bidder will mold it to fit within his business system.

Finally, it should be understood that if the contractor and the Government-sponsored personnel are willing, they can transfer to the company upon completion of the project. If the project is successful, the company will want to do this in order to insure that the technology is effectively transferred. Personnel from the Government-supported laboratory will also perceive their transfer as an opportunity to grow as the application of the technology grows in the company. Thus, we have satisfied principle No. 3 of successful innovation.

If the project is unsuccessful, the company loses only its initial downpayment, and the rest of the loss is spread over the economy in accordance with the justification for the Government undertaking the high-risk project in the first place. Thus, the proposal accomplishes the following things—if we can have the next slide.

First, only those projects are undertaken for which there is a market if they are successful.

Second, projects whose successful outcome is marketable are undertaken which might not be if the government did not underwrite their risk.

Third, the chances of successful innovation occurring from Government supported R&D aimed at the civilian sector is greatly enhanced.

Fourth, the cost of such successful projects are more than recovered by the Government.

Fifth, by a combination of the first third, and fourth, the cost of Government R&D to the taxpayer should be significantly reduced.

The foregoing procedure could be applied to Government-supported R&D within manufacturing companies themselves, if the competition for the research project included a proposal for paying for the exclusive rights to the result in the manner suggested.

Now, just a word about the other Government involvement—the granting of tax incentives for the installation of energy-saving equipment. The Government does grant such tax incentives to individual homeowners now.

I have to assume that the Government has reasoned that the reduction in revenues resulting from such incentives will be offset by a reduction of costs associated with the resulting improved balance of payments or by a reduced vulnerability to economic disruption as a result of reducing our dependence on imported oil.

Although there is a bill proposing it, this tax incentive is not now extended to commercial organizations. It seems to me that all of the reasons which justify doing it for the individual also apply for the commercial organization. In addition, the net loss of revenues would not be as large per unit of energy saved since the commercial firm would have higher income and pay higher income taxes in the long run due to reduced energy costs provided by the new equipment.

Thank you.

Dr. **Crane**. Thank you very much, Don.

Our next speaker is from an industry that is faced with unique problems. Not only does it have production energy costs that are rising, but its products are also large energy consumers in the American economy, this being the automobile industry.

I am pleased to present Frank Daley, director, energy management and plant engineering at the General Motors Corp.

[A biographical sketch of Mr. Daley follows:]

FRANK R. L. DALEY

Frank R. L. Daley, Director of Energy Management and Plant Engineering for General Motors, was appointed to his present position May 1, 1980.

Mr. Daley was born November 18, 1919, in Waltham, Massachusetts, and received a bachelor of science degree in physical and biological sciences from the University of Massachusetts in 1940.

Following service in the U.S. Army during World War II, Mr. Daley joined GM's Chevrolet Division as an assistant resident engineer in 1945. In 1947, he transferred to Buick Motor Division, Flint, Michigan, as a senior design engineer. He was named chassis engineer for Buick in 1961 and in 1964 was appointed chief engineer, Delco Moraine Division, Dayton, Ohio.

In February, 1970, Mr. Daley was transferred to Detroit and named technical assistant to the vice president in charge of the car and truck group. He was appointed Director of Service Research and Development later that year and Director of Technical Services for the Service Section of the GM Marketing Staff in 1971, a post he held until he was named Director of Manufacturing Development in 1972.

Mr. Daley holds a number of patents, is a member of several professional and scientific organizations and is a Certified Manufacturing Engineer and a Professional Engineer registered in Ohio, California and Michigan.

* * *

December, 1980

STATEMENT OF FRANK R. L. DALEY

Mr. **Daley**. Ladies and gentlemen, I have been asked to discuss my company's view of the role of Government in industrial energy conservation and conversion of equipment for more effective utilization of energy resources.

I would like to cover three points: (1) GM's basic conservation program; (2) how GM is looking at conversion to optimize energy sources and processes; and (3) how we believe Government can create an environment more favorable to beneficial change.

I will try to illustrate why we believe, to the greatest extent possible, that free market forces should be encouraged to operate as inducements, while disincentives should be weeded out quickly.

Sometimes, it seems like U.S. industry has only recently discovered the importance of the wise use of energy. Actually, General Motors has paid serious attention to energy efficiency of powerhouses in our manufacturing plants for a long time. Because energy is money, the operating effectiveness of our powerhouses has been monitored, reported, analyzed, and compared since the 1920's.

The energy content of our products was of somewhat less concern than other cost components because energy costs were low enough not to cause much worry. In times past, an engineering study to reduce energy use in some part of the product or process would often show that cost-effectiveness was poor; and it was easy to put off investment by paying a little higher bill from day to day.

In the late 1960's, when stringent and sometimes unbearable environmental requirements were established to protect air quality, the effect was a strong push in the direction of conversion away from coal-fired powerplants. The cost of adding environmental controls to those coal-fired plants was indeed prohibitive compared to the cost of conversion to cheaper oil or gas.

Very shortly afterward, however, it became apparent that the decision to change basic powerplant facilities was being guided by prices which were creating substantial distortions in the energy marketplace. The artificially low regulated prices in gas and oil were encouraging substantial increases in consumption of these fuels. In addition, the low prices depressed interest in exploring for new supplies. The results were a rapidly increasing need for more imports of oil and a growing incidence of interruptions of gas supply.

With natural gas, in particular, efforts were generated to secure allocations to protect production, to install expensive propane equipment as a backup, and to try to find new sources as a backstop to uncertain supplies from utility and pipeline companies.

Just about this time, with our conversion program for environmental purposes in full swing, OPEC dropped the roof on us and petroleum suddenly went critical, both in terms of availability and price. Well-intentioned regulatory programs aimed at addressing supply and price problems which had arisen produced case after case of maldistribution resulting in lines at gasoline stations and other distortions. We are convinced that freedom from artificial constraints would have probably done better with less adversity to our business.

Fortunately, by this time, General Motors already was well started on new product programs for significant increases in fuel economy of our products. For several years, we had seen increasing customer demand for fuel-efficient automobiles that would economically meet mandated clean air requirements. As the price of petroleum began to escalate rapidly, this consumer demand intensified in the marketplace and became clearly evident in our sales mix.

Very soon, the price of petroleum products more nearly reflected their relative value compared to other energy sources. At the same time, intensive patriotic efforts were called for toward the conservation of petroleum and natural gas. Many people were convinced there would not be enough to go around.

Industry people worked hard trying to reserve natural gas for the highest class end uses. Gas was needed for paint drying, for heat-treat furnaces and other process atmospheres. It had to be used as a feedstock for plastics as well as for other manufacturing operations for which substitution would be difficult. The most important need of all was to preserve natural gas for home heating. All these priorities were higher than burning it up to make steam in industrial boilers.

During 1973, General Motors organized its efforts toward industrial conservation. Top level committees had studied the potential effect of shortages or shifts in supply on both product and facilities.

A corporation-wide action program was initiated to apply practical technology to meet the intent of governmental directives as well as to control rapidly rising costs of operation.

GM's energy section communicated to all employees of General Motors the needs and methods for conservation. For example, the movie, "Who, Me? Yes, You!", was seen by over 500,000 employees.

The section provided technical help on engineering improvements and assisted divisions in complying with new complicated regulations.

Many of the initial gains came from tightening up everyday practices about which we had become complacent during the energy-rich years. Now we paid much more attention to turning on and off lights and equipment. We began setting up some fairly sophisticated systems.

Before many of the regulatory requirements were imposed, it was already clear to our development staff that the technology now known as "facilities monitoring and control" could gain significant savings in overall energy costs.

The cost of computer equipment to operate such a system had rapidly come down and could be combined economically with other feature functions such as planning and scheduling of maintenance, operation and control of building security, monitoring of fluid levels for dangerous conditions, and so on.

Further gains in process technology are continuing to bring about additional conservation of energy resources and more effective usage of the different kinds of resources. New plants are being designed with coal-fired equipment and old plants are being retrofitted.

Alternate energy sources are considered in our designs of buildings, including solar, Earth shelter, and application of new materials now sometimes restricted by antiquated codes.

Waste recovery systems are under active development, as exemplified by a unit which has been placed in full service at our Baltimore assembly plant. The system is able to recover energy from waste materials by a mass burning technology.

This system eliminates the need for sorting, crushing, or otherwise preparing waste material for consumption in a boiler which can produce steam usable in plant operations.

The mass burning technology has led to a significant decrease in the operating cost of waste recovery systems. The reduced cost places it within reach of many facilities since it can be used for small-scale as well as large-scale installations.

It is an effective answer to skyrocketing landfill problems and costs.

Improvements are in process for the many different painting systems in our various plants. For example, we are incorporating incinerators and air staging devices, as well as new materials and equipment which reduce the energy requirements for heating, ventilating, and curing of paint.

A new, sophisticated, numerically controlled, robot painting system—developed and manufactured by General Motors—is in pilot operation at Doraville, Ga., painting cars in booths which have no people in them.

In addition to the higher productivity and more uniform quality of this system, elimination of the need for environment conditions tolerable to human workers enables a number of technical advantages in energy requirements, and lower cost of suppressing effluent materials and solvents.

A lot of work has been done on changes in materials and in processing of components for our automotive products. Increasing use of composite plastics and other lightweight structures, along with computer design technology, has enhanced energy efficiency in processes and products.

The reliability of the product when made by alternative methods must be very carefully evaluated before such a change can be safely established. The cost of vehicular and laboratory testing becomes a part of the cost of making such a change. Consequently, such changes are phased into use.

How have we done? In our energy management and conservation program, GM's worldwide efforts through 1980 recorded an overall improvement of plant energy efficiency of 27.7 percent, as compared with 1972 operating levels. Present indicators show that 1981 improvements will increase this to about 30 percent.

Keeping score on this is a complex calculation because of the numerous variables which contribute to measurement of energy effectiveness. Our reports, however, compute the various elements such as changes in factory area, employment, production rates, degree days, and so on.

As a part of this program, our management has established a series of annual goals aimed at reaching a 35-percent level of improvement in energy efficiency by 1985. We are well on the way to accomplishing this goal, thanks to the diligence of staff and divisional people at all levels of GM.

Looking ahead, we are actively working toward coal conversion. GM's coal-fired boilers produce 55 percent of our steam at 46 percent of our total steam cost. The gas and oil-fired boilers produce 45 percent of our steam, but they take up 54 percent of our steam costs. Most of these can be converted to coal only by complete removal and replacement of expensive capital equipment, and might require relocation due to size or other functional needs.

Here is what we think is likely to happen to oil, natural gas, and coal. It looks like the average cost to generate steam in 1985 will be $7 per 1,000 pounds if coal is used, and $17 per 1,000 pounds if oil is used.

At that rate, the cost of coal conversion of one plant under consideration crosses over the fuel cost curve at 1985, after which the payback is such that one can hardly afford not to change. We are currently developing a proposal to management for doing a representative plant to see if this is actually true. Inevitably the natural forces of economics will tell us what to do.

From a national standpoint, Government can accelerate these beneficial moves by fostering research to get over the hurdles that confront us and by diligent elimination of disincentives which create diversions of effort and soak up valuable resources that would be better applied elsewhere. Cutting down on paperwork is a good starting place.

One of my staff, in the process of looking over the wide variety of multipage, multicopy, Government forms, surveys, and reports that General Motors must now prepare with many man-hours of effort, said, "I wonder which form Toyota uses?". We would certainly like to eliminate any requirements of a nonproductive nature that put us at a disadvantage with our very sharp foreign competition and impede our drive to cut costs.

We applaud the many positive measures already taken by the administration to allow operation of free market forces, particularly the President's decision to end petroleum pricing and allocation controls.

Government should guard against implementation of unnecessary regulations in the future. However, necessary governmental functions such as the Strategic Petroleum Reserve can operate efficiently and are necessary to guard against severe import disruptions.

At the same time, we hope efforts will continue to repeal the Fuel Use Act, incremental pricing of natural gas, and other remaining nonproductive regulatory programs in order to reduce regulatory costs to the consumer. Many of these changes will require legislative action.

We are convinced that the decontrol of oil, and the move toward natural gas deregulation, and the elimination of the regulations of the last decade will compel us to continue to use energy more efficiently. In our view, reliance on market forces will achieve optimum levels of cost-effective conservation.

Right now, inside my company, there are powerful incentives based on natural forces helping to persuade people at all levels to move in the right direction with respect to conservation and wise utilization of energy resources. We want to conserve gas for high technology uses, not for producing steam.

Meanwhile, we have our eye on that 35-percent level of improvement by 1985, which is our current conservation target.

Thank you very much.

Dr. **Crane**. Thank you, Frank.

I am delighted to welcome now Maury Gamze, with Gamze-Korobkin-Caloger, Inc., a company that is engaged in designing energy systems for buildings.

[A biographical sketch of Mr. Gamze follows:]

MAURICE G. GAMZE, P.E.

POSITIONS:

1971 -	Principal, Gamze-Korobkin-Caloger, Inc.
1960 - 1971	Partner, Gamze-Korobkin and Associates
1956 - 1960	Engineer, Arthur R. Wallace Consulting Engineers
1950 - 1955	Engineer, Advanced Heating and Air Conditioning Corp. of Chicago

EXPERIENCE:

Mr. Gamze has had over 30 years experience in planning, design and construction of projects and facilities with Gamze-Korobkin-Caloger, Inc., with his own consulting firm, with Arthur R. Wallace Consulting Engineers, and with Advanced Heating and Air Conditioning Corporation of Chicago.

Mr. Gamze's area of practice includes mechanical and electrical systems for buildings and in particular hospitals and institutional buildings, and on-site power and central plant systems. In this latter area he has been responsible for the design, inspection of installation, inspection of start-ups, operation, and evaluation of the actual operation of plants. With almost twenty years of experience in TE, Mr. Gamze has consulted for over a dozen plants, has utilized conventional and advanced technologies such as an Organic Rankine Cycle and fuel cell, and has authored a design primer on TE.

At present, Mr. Gamze is responsible for the design of a small scale multifamily residential cogeneration project with funding from Southern California Gas Co.; is responsible for the design of an active grid connection for an existing TE plant at South Suburban Hospital near Chicago; and has design review responsibilities for approximately 25 commercial, institutional, and industrial sites as part of the Gas Research Institute's field test of fuel cells with heat recovery.

Mr. Gamze has been responsible for GKC's activities in the evaluation and use of automated building energy analysis programs. In this regard he was funded by the International Energy Agency to develop a method by which eighteen different load calculation programs could be compared.

Mr. Gamze has been responsible for the design of mechanical/electrical systems for several hundred buildings with a large number of these being hospitals, schools, correctional facilities, mental health facilities and other institutional and public buildings.

EDUCATION:

1949	B.S., Purdue University, Mechanical Engineering

REGISTRATIONS:

California, Illinois, Indiana, Maryland, Michigan, Minnesota, Missouri, New Jersey, Ohio and Wisconsin

PROFESSIONAL ACTIVITIES:

Chairman, Total Energy and Cogeneration Systems Committee, ASHRAE
Advisor, Princeton University Center for Environmental Studies
Panel Member, Energy Systems, Federal Commission on Science and Technology
Thesis Advisor, School of Architecture, University of Illinois, Chicago Circle Campus

AFFILIATIONS:

Consulting Engineers Council
National Society of Professional Engineers

PUBLICATIONS:

"The Engineer's Analysis of Integrated Energy Systems," with J. A. Orlando, presentation to American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc., Cincinnati, Ohio, June 1981.

Fuel Cell Installation Cost Analysis - Final Report, with J. A. Orlando, L. R. Korobkin, J. T. Valos, prepared for the Gas Research Institute, March 1981.

"A Review of TE System Experience and Design Considerations," presentation to American Gas Association Workshop, New Orleans, LA, November 1980.

"Guidelines for Installing Heat Recovery Fuel Cells in Buildings," with J. A. Orlando, National Fuel Cell Seminar, San Diego, CA, July 1980.

Fuel Cell Building Interface Analysis, with J. A. Orlando, N. Biederman, L. Wichmann, prepared for the Gas Research Institute, December 1979.

"Single Inlet Mixing Unit Provide Air Distribution Economy in Remodeled Office Buildings," Heating, Piping and Air Conditioning.

"What You Should Know About On-Site Energy Systems," Data File, Heating, Piping and Air Conditioning.

"Feasibility of On-Site Energy Systems," Data File, Heating, Piping and Air Conditioning.

"Gas-Fired Turbine Cuts Power Costs," Food Processing.

"Total Energy Systems," Chapter 10, ASHRAE Handbook & Product Director, 1976 Systems Volume, 1976.

"Single Coil Automatic Switch-Over Systems," ASHRAE.

STATEMENT OF MAURICE G. GAMZE

Mr. **Gamze**. Our firm is a consulting engineering firm located in Chicago, and we service a wide clientele, ranging from very large manufacturers and institutions to the Federal Government. I think we are an anomaly in this panel. We are about the only firm today that is not engaged in the production of energy conversion or use products, but rather are engaged in their application.

Much of our work over the years has been in the very mundane areas of heating, ventilating, and air-conditioning for buildings.

There is one group within our company which has been engaged in product development for various manufacturers, and another group has been engaged in policy and economic research.

One thing has come to our attention, due to our particular interest in onsite power generation—which happens to be a major business activity for us. We have very carefully tracked the work related to power conversion equipment that has been done by Federal and private research agencies.

Our tracking of these systems has had a dampening effect on our enthusiasm for Federal involvement in our work. I will only cite several cases, because they go on and on.

I will talk about inverters, since we happen to have present representatives of Borg-Warner and Westinghouse—both of which manufacture inverters.

The Department of Energy has let a contract not too far back, to a manufacturer who is not here, for the development of an inverter to fit into their solar photovoltaic program.

The object of the contract was for this particular manufacturer to reduce the cost of inverters from about $1,000 per kilowatt to about $200 per kilowatt. The agreement was that Government would provide them some money to do the research, and they would develop and market the product.

The Government in its beneficence, granted them the contract without heed of the fact that you can go buy commercial inverters which are far superior to the target inverter at approximately $350 to $550 a kilowatt. We have an infrastructure of the Government and industry all going together into something that is completely unnecessary.

A more telling case has been the history of fuel cells. Fuel cells first came on the market, in terms of research, about 15 to 18 years ago.

Much money has been spent on fuel cells research and development over the years, both privately, through interests of various utility associations such as the Electric Power Research Institute and Gas Research Institute, and through the Federal Government.

Again, costs are the most significant consideration. We were first promised that we could get fuel cells at $200 per kilowatt, $400 per kilowatt, and then $500 per kilowatt.

We recently completed a study in which, based on the technology that was available, we thought that the best estimate for the cost of fuel cells in mass production of thousands of units would never go below about $2,000 to $3,000 per kilowatt.

Of course we are criticized, but being stubborn, we stuck to our guns. It has just recently come to our attention that we were optimistic. Yet many millions have been programed to be spent on this technology. So again, we have a lot of money that is spent on technology for a very questionable market.

On the other hand, we have seen a tremendous number of missed opportunities to capitalize on an invention, on the part of the Government and private industries where the invention has instead shown up overseas.

A typical case in point is the development of the double-cycled absorption refrigeration machine.

I remember a man in California had invented a rather crude two-stage absorber. He went to the gas industry and private manufacturers looking for development money which never came.

Eventually, this machine ended up in Japan, and we are now seeing the machine come back to us in the form of double-effect absorbers.

We are seeing the same thing occur in other refrigeration machinery and other products that our companies are interested in.

If you want to get a superb temperature control system for a building today, you go offshore. If you really want to get the finest for your client, you must look to foreign products—and this is a very sad commentary—because it is not a lack of know-how. The same basic technology was developed in this country by Fishbach & Moore.

He also went around trying to peddle this technology. He sold some rights to a manufacturer who lost interest in it because he could not or did not want to spend the funds to make it cost-competitive with existing technology.

Then the technology sort of disappeared, and a Swiss company picked up on the basic patents. The original patents have run out, and the Swiss are now selling us temperature control systems.

We have a very, very dichotomous series of events to look at when we see this situation in a 30-year perspective.

We see cost overruns and extended programs in Government-sponsored R&D to a much greater extent than in privately sponsored R&D This is because Government has a complete inability to develop a good drop-dead criteria.

In any research program there comes a point where it either has to go forward or drop dead.

If that criteria is not spelled out and rigorously adhered to, it gets very mushy, and the Government will change specifications in order to keep the research going ahead, which further mushes the the goal of the research program.

We see a large infrastructure built up within companies that do a lot of Government R&D. The Government has its people and industry has its people—and the research programs and research groups tend to become self-sustaining. There is not enough effort put forth on either side, at any point in time, in order to cut this string and allow the people to go on and do something else which may be more beneficial.

There are other problems that you are all familiar with in Government-sponsored research—patent problems, the problems of getting the right people to work on the programs.

Another problem is that the Government has an idea that everything must be bid out. This is not always in the best interests of the program. The Government also has ideas that technology must be shared, and perhaps this is a very great disincentive which may keep a company from really going full-out and developing new technology.

Looking at it over a lengthy span of time, I have come to the conclusion that the problems that we have to look at are not so much technological but structural.

The Government has not been a very great success in the development of near-term, or what they call short- to mid-term technology for the energy marketplace.

Perhaps a better approach would be to do what the people in "Silicon Valley" are doing. They have gotten together and developed a trade association type of group, after a Justice Department opinion that it is not a restraint of trade, and are engaging in cooperative technological development.

This effort will probably be much more successful than having the Government direct the technology.

Another structural problem we see is a lack of cash, which was referred to this morning.

Additionally, most corporate people who are involved in research have a very hard time justifying long-term research programs. A case in point is the use of ceramics and gas turbine blading. When I was a student 30 years ago, this technology was just around the corner. It is still around the corner, and there is a basic problem of who is going to pay for it.

One other problem that corporate executives have in looking at corporate research is the difficulty of projecting what the market is going to do. Many times someone can be very successful in a product for which there is no market, and that throws all the market diffusion theorists into a spin—but it happens.

Probably the simplest case I have ever run across is the use of the electric hand dryer. All of you are familiar with this device, which is in service stations and restaurants, a product for which there was no market.

The company has now done a very remarkable job of selling hand dryers; so it is difficult to really foresee in the future. This difficulty also becomes a disincentive for private industry to engage in what are called long-term technologies. So the tendency is to engage in product improvement, to go with what you have and try to make it a little bit better, more cost-effective.

This also, then, does not respond to the need for a long-term perspective. I don't have the solutions to these problems. I hope that eventually some solutions do come about, because they do affect us greatly.

This is probably as appropriate a group as any other to start looking at where the solutions are, I guess.

Thank you.

Dr. **Crane**. Our next speaker is Dr. George Mechlin, vice president for research and development, Westinghouse Electric Corp.

[The biographical sketch of Dr. Mechlin follows:]

Dr. George F. Mechlin

Dr. George F. Mechlin has headed the Westinghouse Research & Development Center since 1973. He attended the University of Pittsburgh, where he received his Ph.D. in Physics in 1951.

Dr. Mechlin joined Westinghouse as a Senior Scientist in 1949. From 1949 through 1957, he worked on the design of submarine propulsion plants at the Bettis Atomic Power Laboratory. He moved to the Westinghouse Marine Division at Sunnyvale, California in 1957. There he participated in the development of the launching systems for the Polaris and Poseidon missiles. His work on the Polaris launcher earned him the U.S. Navy's Meritorious Public Service Award and the Westinghouse Order of Merit.

In 1968, Dr. Mechlin became General Manager of the Underseas Division. Four years later, he became Vice President and General Manager of the Oceanic Divisions. He also was made responsible for the Westinghouse Astronuclear Laboratory.

STATEMENT OF DR. GEORGE F. MECHLIN

Dr. **Mechlin**. Mr. Chairman, ladies and gentlemen, I very much appreciate this opportunity to present my comments on the subject of Government participation in energy research and development.

According to your invitation and agenda, the primary focus of this seminar is to examine what, if any, direct role the Federal Government should play—aside from the performance of long-term, high-risk research and development—to insure that industrial energy conservation proceeds on a satisfactory schedule.

The indicated perspective for this important subject is the contrast between earlier Government attempts to improve the energy efficiency of U.S. industry through extensive programs of research, development, demonstration, and commercialization of energy-efficient processes and hardware; and a more recent approach, relying primarily on the price mechanism to promote industrial energy conservation.

First, there is an important direct role the Federal Government should play, that is, supporting selected research and development programs for industrial energy conservation which benefit U.S. citizens but cannot be supported profitably by private industry.

Second, in many R&D projects important to society, the price mechanism by itself does not provide enough incremental profit to a corporation to justify all R&D costs, since the benefits in many cases tend to accrue to the purchaser. Thus, in my opinion, the private sector will not finance many of the research, development, and demonstration expenditures formerly funded by the Government to conserve industrial energy.

As head of research and development activity for a major electrical manufacturer, I find it impossible to counsel my management to spend more money on R&D for which the price mechanism does not recover our incremental costs and which will not make a competitive return on the capital which must be invested in implementing the R&D.

The most pertinent example which covers the agenda for today's meeting is the Arab oil embargo of 1973, and OPEC's enforced price mechanism for stimulating industrial energy conservation R&D. OPEC oil prices increased from $3 to $12 per barrel in 1973 and from $15 to $34 per barrel in the period 1978–80. This tenfold price increase of crude oil has motivated Government expenditures for energy R&D throughout the world, to utilize national resources and to reduce oil import requirements. Private industry has funded energy R&D for profit motives, in addition to implementing Government-funded energy development projects.

To evaluate how response to the OPEC price mechanism might reward private industry for investing in industrial energy conservation R&D, it is informative to review the trends in energy use by various sectors of the U.S. economy—before and after 1973—as an experiment illustrating energy price elasticity.

Figures 1 through 8 [referring to slides] graphically illustrate each sector's reaction to higher energy prices and supply concerns, that emerged subsequent to the embargo. [See attached statement.]

Contrary to popular belief, the residential and commercial sectors, shown in figures 1, 2, 3 and 4, have exhibited the greatest deviations from historical trends.

These trend changes were achieved mainly by increased thermal insulation, better heat loss control, and more disciplined use of heating, lighting, and air-conditioning.

The next two figures, 5 and 6, show that the transportation sector also had a definite trend change in response to higher oil prices. The introduction of more energy-efficient automobiles is an important factor in this change.

The price mechanism influence, plus the Government-edicted mileage increases in the automotive sector, certainly seem to have achieved the results that we saw there. Some transportation energy conservation R&D, however, did not pay off. For example, a much publicized example is the Cadillac's selective 4-6-8 cylinder gasoline economizer, which has been withdrawn from the market.

However, more energy-efficient fanjets provided significant fuel savings for the airlines, and increased significantly the sales for jet engine suppliers. Here the Government-supported development for military aircraft jet engines was a big factor, in addition to the price mechanism.

The industrial sector also has responded to changes stimulated by the embargo. Figure 7 shows that only the industrial sector had a history of reducing its nonelectric energy use on a per-unit basis. Figure 7 also shows that, while industry has improved its nonelectric energy efficiency subsequent to the embargo, the improvement is comparable to its historical concern for energy use—and does not reflect a deviation from trend motivated by markedly higher energy prices. I'll comment later on the economic logic of a continuing trend for increased use of electric energy per industrial output unit as shown in figure 8.

Figure 9 contrasts the energy price history for the pre- and post-embargo period. With the exception of coal, real energy prices of all energy forms—after discounting for inflation—were declining prior to the embargo.

After the embargo, heating oil increased 15 percent annually; natural gas, although subject to price controls, increased 13 percent per year and coal prices increased 9 percent annually. Despite the steep price increases for the various fuels used to produce electricity, two factors contributed to the more moderate price movement for electricity.

First, fuel costs account for less than 40 percent of the delivered cost of electricity.

In addition, electric utilities shifted from expensive fuel oil toward less expensive coal and uranium. For example, electric utility fuel prices in 1980 for oil, coal and uranium were $4.30, $1.35, and 40 cents per million Btu's respectively.

Second, electric utilities are one of the most capital-intensive industries with large long-term investments required for generation, transmission, and distribution. Over 70 percent of the capital equipment required in 1980 was in place prior to 1973 and was thus unaffected by the general inflation that occurred subsequent to the embargo.

The more moderate price increase for electricity, shown in figure 9, provides economic logic for the industrial electrical use trend. This trend, shown previously in figure 8, depicts how electrical energy is being increasingly used to displace nonelectric energy.

Increased use of electricity is motivated not only by energy price trends but also by the increased effectiveness of capital, improved labor productivity and increased automation. Examples from this latter category of motivations include heat pumps, pollution controls, robots, and electric furnaces.

The next slide, please.

The complex motivations just reviewed together with the results shown in figure 10 illustrate deviations from pre-embargo trends.

Figure 10 summarizes how energy demand patterns for the various sectors have changed since 1973. This tabulation suggests that, while energy demand in 1980 was higher than in 1973, the amount of energy consumed in 1980 was 20 percent below the level expected if pre-embargo trends had continued. This departure from historical patterns represents about 20×10^{15} Btu, which is equivalent to all the energy used to meet national transportation needs during 1980.

The trends which are used for long-term R&D planning are thus subject to perturbations which indicate limitations, relative to the price mechanism payoff, for industrial energy conservation R&D funded by the private sector. Both high efficiency fuel cells and photovoltaic conversion of solar energy have potential benefit to society, but require Government funding for development, because of long-term, uncertain economic results.

We would like to recover energy R&D expenditures by selling the improved energy conversion equipment to our major customer, the electric utility industry. However, the present economic environment in electric utilities does not favor major capital investment in new energy-efficient equipment.

The electric utility annual energy growth rate of over 7 percent from World War II to 1973 is now less than 3 percent per year. As a result, generation plants ordered earlier are now being canceled. Utility financing alternatives for the purchase of major new capital equipment are: high interest rate loans, downgraded bonds saleable only at high discounts, or diluted stockholder equity by sale of common stock at a market price 60 to 80 percent of book value. These price mechanisms do not favor recovery of R&D expenditures by an equipment supplier.

In addition, efficiency improvements of energy conversion equipment result in lower fuel bills for the utilities and their customers—the residential, commercial, and industrial users who benefit—but not necessarily for the manufacturer who improves the machines.

Figure 11 illustrates comparative economic benefits obtained by the manufacturer—about a 20-percent return on an investment of less than $50 million—compared to utility benefits of over four times that much, involved in developing a superconducting generator.

A basic impediment to industrial energy conservation developments of this type is the long-term, cumulative negative cash flow illustrated in this figure, which leads to poor return on investment.

Just to comment, the line in red represents the cash flow to the manufacturer. The line in blue represents the benefit to the utility. You will notice that the maximum financial benefit to the utility occurs at a much earlier time and is much, much larger than the benefit which accrues to the manufacturer.

The yellow and orange lines simply show you the savings in fuel that such a machine would provide, and the line in orange shows the electrical output on a cumulative basis of such a machine.

The user of the equipment obviously is the one who gets the benefit, and the producer finds it very difficult to recover his R&D expenses.

Now the utilities, in this case, have recognized the benefit available from the increased efficiency of the superconducting generator, and are providing some funds for development of a 300 MW unit. This is being done by the Electric Power Research Institute [EPRI]. However, one cannot imagine that the capabilities of this institute will in any way approach the Federal capabilities which are being displaced.

The total budget of EPRI is currently several hundred million dollars a year, which is a tiny fraction of the Federal budget; and there are major political constraints on efforts to increase it. So indeed, even this source does not represent an alternative to Federal funding.

Another example of energy conversion equipment R&D which could provide more energy for society than all the fossil fuel reserves in the world is the breeder reactor. Constructing a breeder now with Government funds, cost-shared by utilities, is not a long-term, high-risk research project but, rather, a necessary first step in an important program vital to the long-range interests of the United States and to the world.

Just because of the temporary world surplus of oil and gas, and the fact that OPEC has not doubled oil prices in the last year, does not mean that our Government should completely abandon energy R&D to the expedients of price mechanism motivation. Enhanced oil recovery, shale oil, synthetic liquid and gaseous fuels, and other alternate energy developments to displace the use of imported oil are all programs of benefit to U.S. society and hence should be stimulated by Government funding.

This is not to say that the price mechanism is totally ineffective because it has, to some extent, motivated electric utilities to increase efficiency. For example, the superconducting generator development, referred to earlier, is being funded partially by the Electric Power Research Institute because it has the potential to increase plant efficiency by 1 percent. If 1 percent of the 25×10^{15}

Btu of energy used this year by electric utilities to generate 2,400 billion kWh were saved, it would be worth $300 million at coal prices of $30 per ton, or a $1 billion at oil prices of $25 per barrel.

Another partially effective price mechanism for electric utilities is forced outage, or unavailability of powerplants. As a result, utilities have had their vendors develop better methods to predict equipment failures, so preventive maintenance can be more effective.

Figure 12 illustrates how the cost to a utility of 1 day of unavailability for a fossil-fueled 500-MW powerplant has increased, from about $30,000 per day in 1970 to over $500,000 per day in 1980. This $500,000 can be obtained by calculating 2 cents per kWh for replacement power, plus similar fixed costs for the inoperative plant.

I am pleased that Congress is evaluating Government policies on R&D. I hope you will convince the present Administration that certain industrial energy research and development programs can provide significant benefits to the people of the United States. These benefits will be available only if the programs are funded by our Government.

Thank you.

Dr. **Crane**. Thank you very much.

[Attachments to statement follow:]

[The prepared statement, plus figs. 1-12, of Mr. Mechlin follow:]

INDUSTRIAL ENERGY CONSERVATION
ENERGY CONVERSION EQUIPMENT

DR. GEORGE F. MECHLIN
VICE PRESIDENT - RESEARCH AND DEVELOPMENT
WESTINGHOUSE ELECTRIC CORPORATION

FEBRUARY 11, 1982
CONGRESSIONAL RESEARCH SERVICE SEMINAR
LIBRARY OF CONGRESS
WASHINGTON, D.C.

MR. CHAIRMAN, MEMBERS OF CONGRESS AND STAFF, MEMBERS OF THE CONGRESSIONAL RESEARCH SERVICE, AND FELLOW SPEAKERS, GOOD AFTERNOON. I AM GEORGE MECHLIN, VICE PRESIDENT FOR RESEARCH AND DEVELOPMENT OF WESTINGHOUSE ELECTRIC CORPORATION. I APPRECIATE THIS OPPORTUNITY TO PRESENT TO YOU OUR COMMENTS ON ENERGY RESEARCH AND DEVELOPMENT.

ACCORDING TO YOUR INVITATION AND AGENDA, THE PRIMARY FOCUS OF THIS SEMINAR IS TO EXAMINE WHAT, IF ANY, DIRECT ROLE THE FEDERAL GOVERNMENT SHOULD PLAY, ASIDE FROM THE PERFORMANCE OF LONG-TERM, HIGH RISK RESEARCH AND DEVELOPMENT, IN INDUSTRIAL ENERGY CONSERVATION, TO ENSURE THAT IT PROCEEDS ON A SATISFACTORY SCHEDULE. THE INDICATED PERSPECTIVE FOR THIS IMPORTANT SUBJECT, IS THE CONTRAST BETWEEN EARLIER GOVERNMENT ATTEMPTS TO IMPROVE THE ENERGY EFFICIENCY OF U.S. INDUSTRY THROUGH EXTENSIVE PROGRAMS OF RESEARCH, DEVELOPMENT, DEMONSTRATION AND COMMERCIALIZATION OF ENERGY EFFICIENT PROCESSES AND HARDWARE; AND A MORE RECENT APPROACH, RELYING PRIMARILY ON THE PRICE MECHANISM TO PROMOTE INDUSTRIAL ENERGY CONSERVATION.

MY RESPONSE IN SUMMARY TO THE NEW GOVERNMENT POLICY IS:

1. THERE IS AN IMPORTANT DIRECT ROLE THE FEDERAL GOVERNMENT SHOULD PLAY, I.E. SUPPORTING SELECTED RESEARCH AND DEVELOPMENT PROGRAMS FOR INDUSTRIAL ENERGY CONSERVATION, WHICH BENEFIT U.S. CITIZENS BUT CANNOT BE SUPPORTED PROFITABLY BY PRIVATE INDUSTRY, AND

2. IN MANY R&D PROJECTS, IMPORTANT TO SOCIETY, THE PRICE MECHANISM BY ITSELF, DOES NOT PROVIDE ENOUGH INCREMENTAL PROFIT TO A CORPORATION TO JUSTIFY ALL R&D COSTS, SINCE THE BENEFITS TEND TO ACCRUE TO THE PURCHASER. THUS IN MY OPINION, THE PRIVATE SECTOR WILL NOT FINANCE MANY OF THE RESEARCH, DEVELOPMENT AND DEMONSTRATION EXPENDITURES FORMERLY FUNDED BY THE GOVERNMENT TO CONSERVE INDUSTRIAL ENERGY.

AS HEAD OF RESEARCH AND DEVELOPMENT FOR A MAJOR ELECTRICAL MANUFACTURER, I FIND IT IMPOSSIBLE TO COUNSEL MY MANAGEMENT TO SPEND MORE MONEY ON R&D FOR WHICH THE PRICE MECHANISM DOES NOT RECOVER OUR INCREMENTAL COSTS AND WHICH WILL NOT MAKE A COMPETITIVE RETURN ON THE CAPITAL WHICH MUST BE INVESTED IN IMPLEMENTING THE R&D.

THE MOST PERTINENT EXAMPLE WHICH COVERS THE AGENDA FOR TODAY'S MEETING IS THE ARAB OIL EMBARGO OF 1973, AND

OPEC'S ENFORCED PRICE MECHANISM FOR STIMULATING INDUSTRIAL ENERGY CONSERVATION R&D. OPEC OIL PRICES INCREASED FROM $3 TO $12 PER BARREL IN 1973 AND FROM $15 TO $34 PER BARREL IN THE PERIOD 1978-1980. THIS TENFOLD PRICE INCREASE OF CRUDE OIL HAS MOTIVATED GOVERNMENT EXPENDITURES FOR ENERGY R&D THROUGHOUT THE WORLD, TO UTILIZE NATIONAL RESOURCES AND REDUCE OIL IMPORT REQUIREMENTS. PRIVATE INDUSTRY HAS FUNDED ENERGY R&D FOR PROFIT MOTIVES, IN ADDITION TO IMPLEMENTING GOVERNMENT FUNDED ENERGY DEVELOPMENT PROJECTS.

TO EVALUATE HOW RESPONSE TO THE OPEC PRICE MECHANISM MIGHT REWARD PRIVATE INDUSTRY FOR INVESTING IN INDUSTRIAL ENERGY CONSERVATION R&D, IT IS INFORMATIVE TO REVIEW THE TRENDS IN ENERGY USE, BY VARIOUS SECTORS OF THE U.S. ECONOMY, BEFORE AND AFTER 1973, AS AN EXPERIMENT ILLUSTRATING ENERGY PRICE ELASTICITY.

FIGURES 1 THROUGH 8 GRAPHICALLY ILLUSTRATE EACH SECTOR'S REACTION TO HIGHER ENERGY PRICES, AND SUPPLY CONCERNS, THAT EMERGED SUBSEQUENT TO THE EMBARGO. CONTRARY TO POPULAR BELIEF, THE RESIDENTIAL AND COMMERCIAL SECTORS, HAVE EXHIBITED THE GREATEST DEVIATIONS FROM HISTORICAL TRENDS, AS ILLUSTRATED BY FIGURES 1, 2, 3 AND 4. THESE TREND CHANGES WERE ACHIEVED MAINLY BY INCREASED THERMAL INSULATION, BETTER HEAT LOSS CONTROL, AND MORE DISCIPLINED USE OF HEATING, LIGHTING, AND AIR CONDITIONING. FIGURES 5 AND 6 SHOW THAT THE TRANSPORTATION SECTOR HAD A DEFINITE

TREND CHANGE RESPONSE TO HIGHER OIL PRICES, WITH MORE ENERGY-EFFICIENT AUTOMOBILES AN IMPORTANT FACTOR. PRICE MECHANISM INFLUENCE, PLUS GOVERNMENT EDICTED MILEAGE INCREASES HELPED ACHIEVE THE RESULTS. SOME TRANSPORTATION ENERGY CONSERVATION R&D DID NOT PAY OFF, FOR EXAMPLE CADILLAC'S SELECTIVE 4, 6, 8 CYLINDER GASOLINE ECONOMIZER, BUT THE MORE ENERGY EFFICIENT FAN JETS PROVIDED SIGNIFICANT FUEL SAVINGS FOR THE AIR LINES, AND INCREASED SALES FOR JET ENGINE MANUFACTURERS. GOVERNMENT SUPPORTED DEVELOPMENT FOR MILITARY AIRCRAFT JET ENGINES WAS A BIG FACTOR, IN ADDITION TO THE PRICE MECHANISM.

THE INDUSTRIAL SECTOR ALSO HAS RESPONDED TO CHANGES STIMULATED BY THE EMBARGO. FIGURE 7 SHOWS THAT ONLY THE INDUSTRIAL SECTOR HAD A HISTORY OF REDUCING ITS NONELECTRIC ENERGY USE ON A PER-UNIT BASIS. FIGURE 7 SHOWS THAT, WHILE INDUSTRY HAS IMPROVED ITS NONELECTRIC ENERGY EFFICIENCY SUBSEQUENT TO THE EMBARGO, THE IMPROVEMENT IS COMPARIBLE TO ITS HISTORICAL CONCERN FOR ENERGY USE, AND DOES NOT REFLECT A DEVIATION FROM TREND MOTIVATED BY MARKEDLY HIGHER ENERGY PRICES. I'LL COMMENT LATER ON THE ECONOMIC LOGIC OF A CONTINUING TREND FOR INCREASED USE OF ELECTRIC ENERGY PER INDUSTRIAL OUTPUT UNIT SHOWN IN FIGURE 8.

FIGURE 9 CONTRASTS THE ENERGY PRICE HISTORY FOR THE PRE AND POST-EMBARGO PERIOD. WITH THE EXCEPTION OF COAL, REAL ENERGY PRICES, AFTER DISCOUNTING FOR INFLATION, OF ALL

ENERGY FORMS, DECLINED PRIOR TO THE EMBARGO. AFTER THE EMBARGO, HEATING OIL INCREASED 15% ANNUALLY, NATURAL GAS, ALTHOUGH SUBJECT TO PRICE CONTROLS, INCREASED 13% PER YEAR AND COAL PRICES INCREASED 9% ANNUALLY.

DESPITE THE STEEP PRICE INCREASES FOR THE VARIOUS FUELS USED TO PRODUCE ELECTRICITY, TWO FACTORS CONTRIBUTED TO THE MORE MODERATE PRICE MOVEMENT FOR ELECTRICITY.

- FIRST, FUEL COSTS ACCOUNT FOR LESS THAN 40% OF THE DELIVERED COST OF ELECTRICITY. IN ADDITION ELECTRIC UTILITIES SHIFTED FROM EXPENSIVE FUEL OIL, TOWARD LESS EXPENSIVE COAL AND URANIUM. FOR EXAMPLE, ELECTRIC UTILITY FUEL PRICES IN 1980 FOR OIL, COAL AND URANIUM WERE $4.30, $1.35, AND $.40 PER MILLION BTU RESPECTIVELY.

- SECOND, ELECTRIC UTILITIES ARE ONE OF THE MOST CAPITAL INTENSIVE INDUSTRIES WITH LARGE, LONG TERM INVESTMENTS REQUIRED FOR GENERATION, TRANSMISSION AND DISTRIBUTION. OVER 70% OF THE CAPITAL EQUIPMENT REQUIRED IN 1980 WAS IN PLACE PRIOR TO 1973, AND WAS THUS UNAFFECTED BY THE GENERAL INFLATION THAT OCCURRED SUBSEQUENT TO THE EMBARGO.

The more moderate price increase for electricity shown in Figure 9, provides economic logic for the industrial electrical energy use trend, shown previously in Figure 8, in which electric energy is being increasingly used to displace nonelectric energy. Increased use of electricity is motivated, not only by energy price trends, but also by increased effectiveness of capital, improved labor productivity and more automation. Examples are the heat pump, pollution controls, robots, and electric furnaces.

The involved interaction just reviewed, and results shown in Figure 10, illustrate deviations from pre embargo trends. Figure 10 summarizes how energy demand patterns for the various sectors have changed since 1973. This tabulation suggests that, while energy demand in 1980 was higher than in 1973, the amount of energy consumed in 1980 was 20% below the level expected, if pre embargo trends had continued. This departure from historical patterns represents about $20\ 10^{15}$ Btu, or all the energy used to meet transportation needs of the nation in 1980.

The trends which are used for long term R&D planning are thus subject to perturbations which indicate limitations, relative to price mechanism pay off, for industrial energy conservation R&D funded by the private sector. Both high efficiency fuel cells, and photovoltaic

CONVERSION OF SOLAR ENERGY, HAVE POTENTIAL BENEFIT TO SOCIETY, BUT REQUIRE GOVERNMENT FUNDING FOR DEVELOPMENT, BECAUSE OF LONG TERM, UNCERTAIN ECONOMIC RESULTS.

WE WOULD LIKE TO RECOVER ENERGY R&D EXPENDITURES, BY SELLING THE IMPROVED ENERGY CONVERSION EQUIPMENT TO OUR MAJOR CUSTOMER, THE ELECTRIC UTILITY INDUSTRY. HOWEVER, THE PRESENT ECONOMIC ENVIRONMENT IN ELECTRIC UTILITIES DOES NOT FAVOR MAJOR CAPITAL INVESTMENT IN NEW ENERGY EFFICIENT EQUIPMENT. THE ELECTRIC UTILITY ENERGY ANNUAL GROWTH RATE, OF OVER 7% FROM WORLD WAR II TO 1973, IS NOW LESS THAN 3% PER YEAR, SO GENERATION PLANTS, ORDERED EARLIER, ARE BEING CANCELLED. UTILITY FINANCING ALTERNATIVES FOR PURCHASE OF MAJOR NEW CAPITAL EQUIPMENT ARE: HIGH INTEREST RATE LOANS, DOWNGRADED BONDS SALEABLE ONLY AT HIGH DISCOUNTS, OR DILUTED STOCKHOLDER EQUITY BY SALE OF COMMON STOCK AT A MARKET PRICE 60-80% OF BOOK VALUE. THESE PRICE MECHANISMS DO NOT FAVOR RECOVERY OF R&D EXPENDITURES BY A SUPPLIER. IN ADDITION, EFFICIENCY IMPROVEMENTS OF ENERGY CONVERSION EQUIPMENT, RESULT IN LOWER FUEL BILLS FOR THE UTILITIES, AND THEIR CUSTOMERS, THE RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL USERS, WHO BENEFIT, BUT NOT NECESSARILY THE MANUFACTURER WHO IMPROVES THE MACHINES.

FIGURE 11 ILLUSTRATES COMPARATIVE ECONOMIC BENEFITS OBTAINED BY THE MANUFACTURER -- ABOUT 20% RETURN ON INVESTMENT OF LESS THAN $50 MILLION -- COMPARED TO UTILITY

BENEFITS OF OVER FOUR TIMES THAT MUCH, INVOLVED IN DEVELOPING A SUPERCONDUCTING GENERATOR. A BASIC IMPEDIMENT TO INDUSTRIAL ENERGY CONSERVATION DEVELOPMENT OF THIS TYPE IS THE LONG TERM CUMULATIVE NEGATIVE CASH FLOW ILLUSTRATED IN THIS FIGURE, WHICH LEADS TO POOR RETURN ON INVESTMENT. FOR THIS CASE, UTILITIES RECOGNIZED THE BENEFITS AVAILABLE FROM THE INCREASED EFFICIENCY OF THE SUPERCONDUCTING GENERATOR, AND ARE PROVIDING SOME FUNDS FOR DEVELOPMENT OF A 300 MW UNIT.

ANOTHER EXAMPLE OF ENERGY CONVERSION EQUIPMENT R&D, WHICH COULD PROVIDE MORE ENERGY FOR SOCIETY THAN ALL THE FOSSIL FUEL RESERVES IN THE WORLD, IS THE BREEDER REACTOR. CONSTRUCTING A BREEDER NOW WITH GOVERNMENT FUNDS, COST SHARED BY UTILITIES, IS NOT A LONG TERM, HIGH RISK RESEARCH PROJECT, BUT RATHER A NECESSARY FIRST STEP IN AN IMPORTANT PROGRAM VITAL TO THE U.S. AND TO THE WORLD.

JUST BECAUSE OF THE TEMPORARY WORLD SURPLUS OF OIL AND GAS, AND THE FACT THAT OPEC HAS NOT DOUBLED OIL PRICES LATELY, DOES NOT MEAN THAT OUR GOVERNMENT SHOULD COMPLETELY ABANDON ENERGY R&D TO THE EXPEDIENTS OF PRICE MECHANISM MOTIVATION. ENHANCED OIL RECOVERY, SHALE OIL, SYNTHETIC LIQUID AND GASEOUS FUELS, AND ALTERNATE ENERGY DEVELOPMENTS TO DISPLACE USE OF IMPORTED OIL, ARE ALL PROGRAMS OF BENEFIT TO U.S. SOCIETY AND HENCE SHOULD BE STIMULATED BY GOVERNMENT FUNDING.

THIS ISN'T TO SAY THAT THE PRICE MECHANISM IS TOTALLY INEFFECTIVE, BECAUSE IT HAS, TO SOME EXTENT, MOTIVATED ELECTRIC UTILITIES TO INCREASE EFFICIENCY. FOR EXAMPLE, THE SUPERCONDUCTING GENERATOR DEVELOPMENT, REFERRED TO EARLIER, IS BEING FUNDED PARTIALLY BY THE ELECTRIC POWER RESEARCH INSTITUTE, BECAUSE POTENTIALLY IT CAN INCREASE PLANT EFFICIENCY .7 TO 1%. IF 1% OF THE 25 10^{15} BTU OF ENERGY, USED THIS YEAR BY ELECTRIC UTILITIES TO GENERATE 2400 BILLION KWH, WERE SAVED, IT WOULD BE WORTH $300 MILLION AT COAL PRICES OF $30 PER TON, OR A BILLION DOLLARS AT OIL PRICES OF $25 PER BARREL.

ANOTHER PARTIALLY EFFECTIVE PRICE MECHANISM FOR ELECTRIC UTILITIES IS FORCED OUTAGE, OR UNAVAILABILITY OF POWER PLANTS. AS A RESULT, UTILITIES HAVE HAD THEIR VENDORS DEVELOP BETTER METHODS TO PREDICT EQUIPMENT FAILURES, SO PREVENTATIVE MAINTENANCE CAN BE MORE EFFECTIVE. FIGURE 12 ILLUSTRATES HOW THE COST TO A UTILITY, OF ONE DAY OF UNAVAILABILITY FOR A FOSSIL FUELED 500 MW POWER PLANT, HAS INCREASED, FROM ABOUT $30,000 IN 1970, TO OVER $500,000 IN 1980. THE $500,000 CAN BE CALCULATED FROM 2¢ PER KWH FOR REPLACEMENT POWER, PLUS SIMILAR FIXED COSTS IN THE INOPERATIVE PLANT.

I AM PLEASED THAT CONGRESS IS EVALUATING GOVERNMENT POLICIES ON R&D. I HOPE YOU WILL CONVINCE THE PRESENT ADMINISTRATION THAT CERTAIN INDUSTRIAL ENERGY RESEARCH AND DEVELOPMENT PROGRAMS CAN PROVIDE SIGNIFICANT BENEFITS TO THE PEOPLE OF THE UNITED STATES, WHICH WILL BE AVAILABLE ONLY IF THE PROGRAMS ARE FUNDED BY OUR GOVERNMENT. THANK YOU.

FIGURES

1. RESIDENTIAL NONELECTRIC ENERGY USE
2. RESIDENTIAL ELECTRICITY USE
3. COMMERCIAL NONELECTRIC ENERGY USE
4. COMMERCIAL ELECTRICITY USE
5. TRANSPORTATION ENERGY USE PER PASSENGER CAR
6. TRANSPORTATION ENERGY USE PER TRUCK
7. INDUSTRIAL NONELECTRIC ENERGY USE
8. INDUSTRIAL ELECTRICITY USE
9. REAL ENERGY PRICE CHANGES
10. PERCENTAGE THAT ACTUAL ENERGY USE IN 1980 WAS BELOW THE PRE-EMBARGO TREND
11. SUPERCONDUCTING GENERATOR
12. COST TO UTILITY OF ONE DAY UNAVAILABILITY FOR 500 MW FOSSIL UNIT

RESIDENTIAL ENERGY USE PER HOUSEHOLD

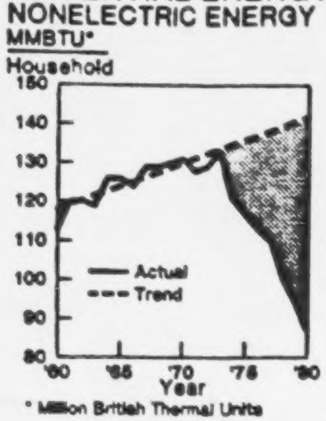


Figure 1

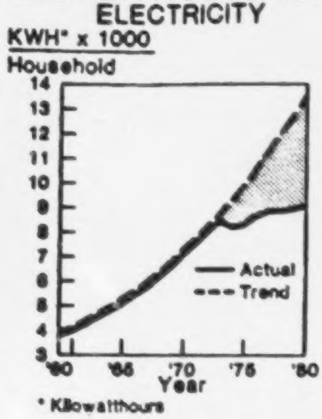


Figure 2

COMMERCIAL ENERGY USE PER COMMERCIAL EMPLOYEE

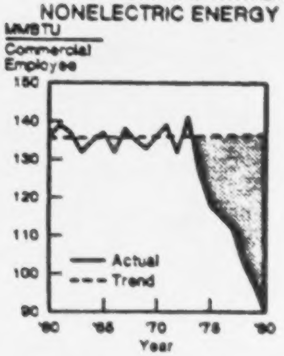


Figure 3

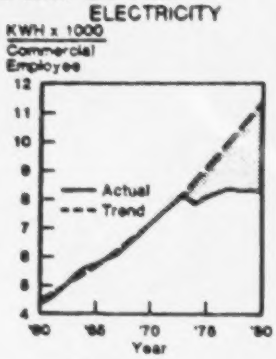


Figure 4

TRANSPORTATION ENERGY USE PER VEHICLE

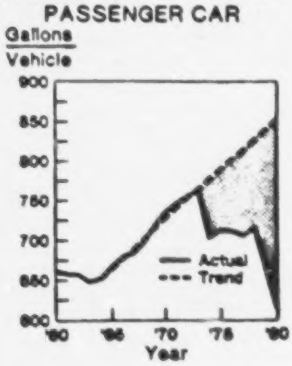


Figure 5

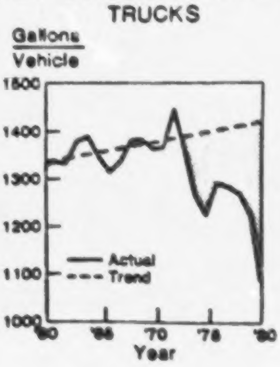


Figure 6

INDUSTRIAL ENERGY USE
PER INDUSTRIAL PRODUCTION INDEX

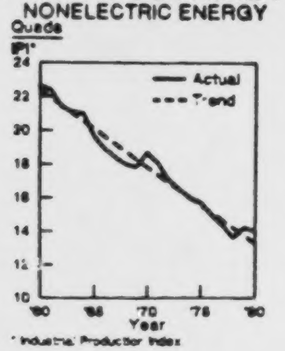


Figure 7

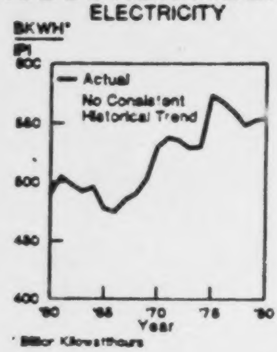


Figure 8

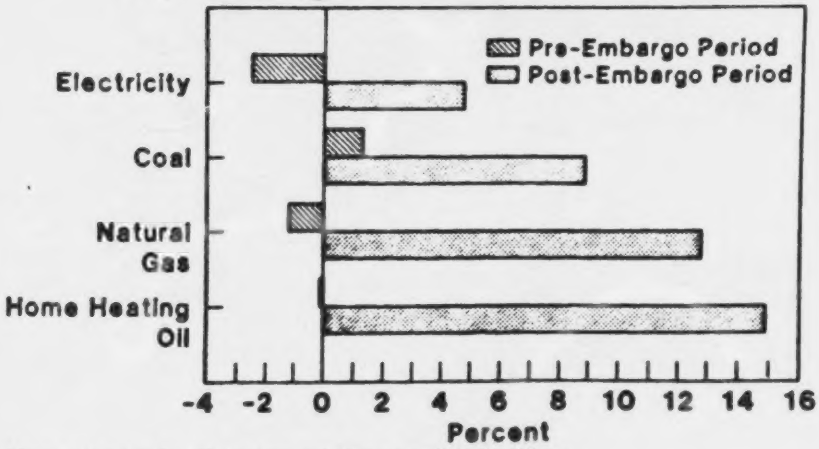
PERCENTAGE THAT ACTUAL ENERGY USE IN 1980 WAS BELOW THE PRE-EMBARGO TREND

End-User Sector	Nonelectric Energy	Electricity	Total
Residential	-39	-33	-35
Commercial	-34	-27	-31
Industrial	N.C.	N.C.	N.C.
Transportation	-22	--	-22
TOTAL ECONOMY	-20	-20	-20

N.C. = No Change Discernable

Figure 9

REAL* ENERGY PRICE CHANGES (Average Annual Rate)



*Increases in Excess of General Inflation

Figure 10

SUPERCONDUCTING GENERATOR

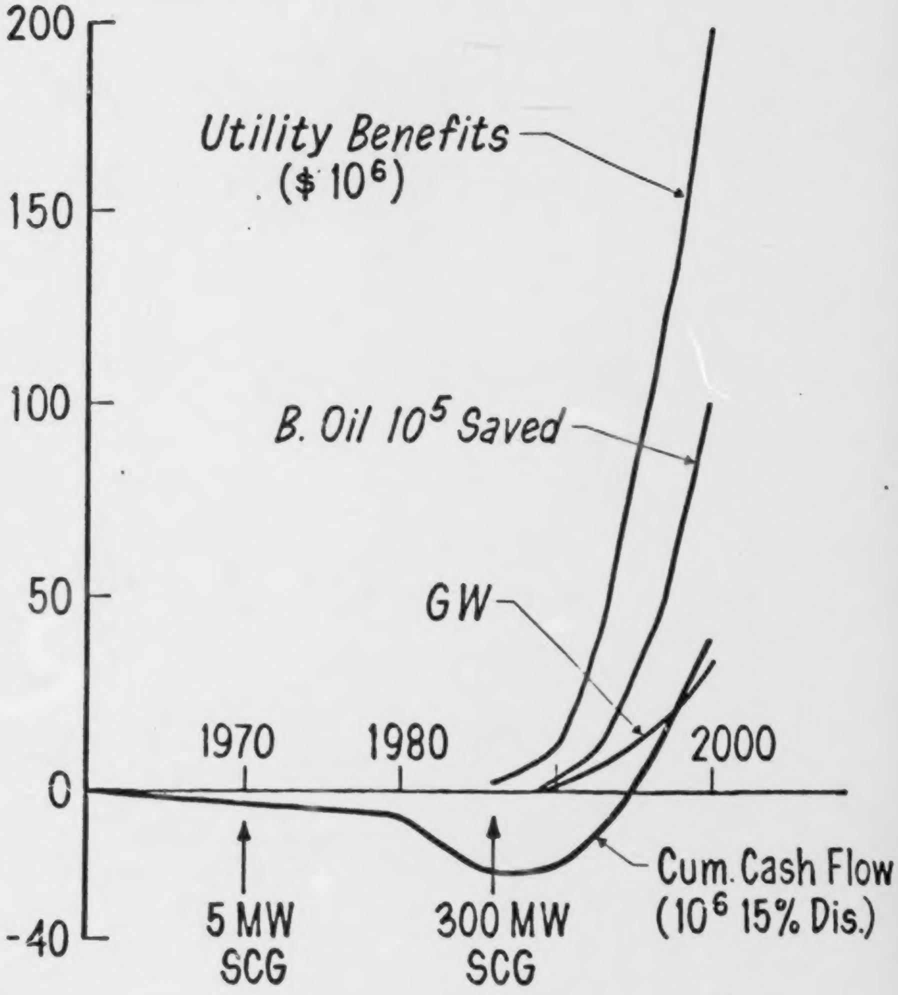
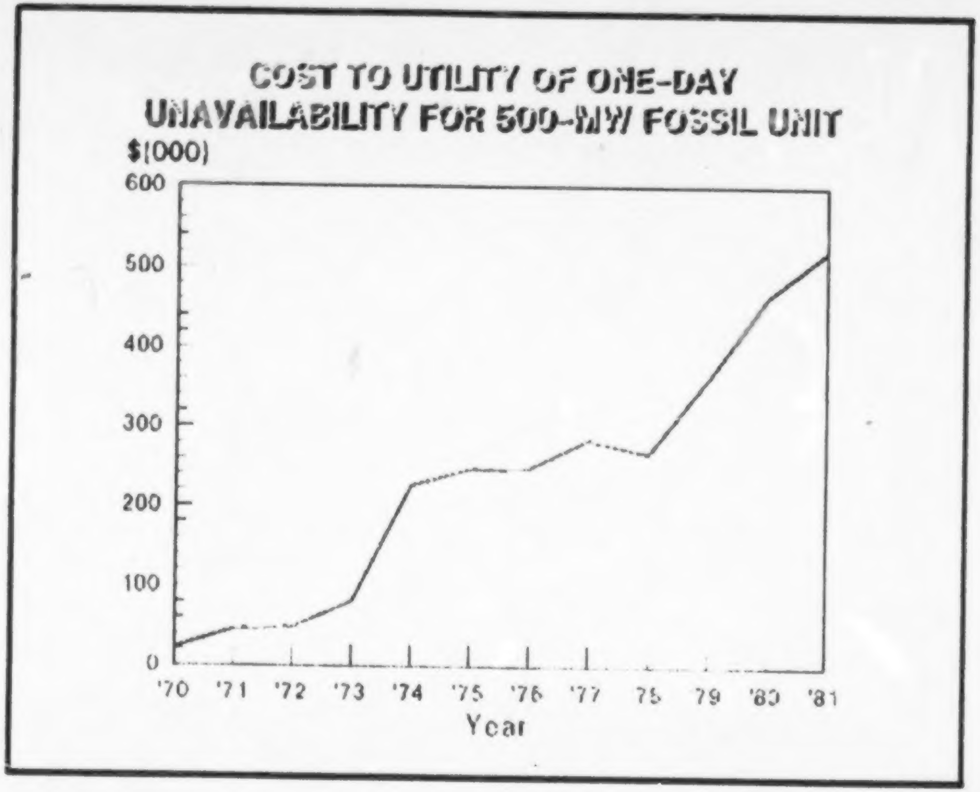


Figure 11


COST TO UTILITY OF ONE-DAY
UNAVAILABILITY FOR 500-MW FOSSIL UNIT
$(000)
600
500
400
300
200
100
0
'70
'71
'72
'73
'74
'75
'76
'77
'78
'79
'80
'81
Year

Dr. CRANE. Our last panelist is Stanley Schroeder, general counsel and director of Legislative Services of the Gas Appliance Manufacturers Association.

[A biographical sketch of Mr. Schroeder follows:]

STANLEY W. SCHROEDER

Mr. Schroeder serves both as General Counsel and Director of Legislative Services for the Gas Appliance Manufacturers Association [GAMA] in Arlington, Virginia. He has been in private law practice in Washington, D.C. and New York working with trade associations and other industry groups. He is particularly well qualified to counsel trade associations. Before coming to GAMA, he worked for seven years as an associate and partner with George P. Lamb, the "father" of trade association anti-trust law.

Earlier experience includes positions as Assistant Legal Counsel for the American Mining Congress, legal advisor to a public relations firm, and tariff and customs work with a New York law firm. He started his career working for the Federal Government in the General Counsel's Office of the U.S. Tariff Commission.

Mr. Schroeder is a graduate of Yale University, and holds LLB and LLM degrees from Georgetown University. He is admitted to practice law in Washington, D.C., New York, and the U.S. Supreme Court.

STATEMENT OF STANLEY W. SCHROEDER

Mr. SCHROEDER. Good morning.

I am pinch-hitting on your program for Jack Langmead, who had to be out of town.

That was an awesome assignment for Jack as well as myself to try to figure out how we address ourselves to the panel's assignment. We figured that we probably would best serve this audience and our task by just trying to give you a trade association's perceptions on how best to identify and get the research done.

Let me give you a little bit of background about our trade association. It is the Gas Appliance Manufacturers Association [GAMA], a national trade association. Our members manufacture over 90 percent of the gas appliances and equipment sold in the United States.

We really are about 13 different trade associations. We call them product divisions, each of which operates under the administrative umbrella of our association.

On the residential side, we have a furnace division, water division, range division; on the commercial and industrial side we have an industrial heating division, a food service equipment division, and an infrared division. We also have a controls division which services all of these other divisions. In addition, we have a general equipment division, which represents the manufacturers of the equipment, machinery, supplies, materials, engineering, and technical services used in the transmission and distribution of fuel gases. Some of the members of that division are companies which you recognize, such as Rockwell International, Singer Co., Dresser, and T. D. Williamson.

The equipment division sells primarily to the gas utilities and the transmission companies.

I might also point out that there is no such thing as a gas appliance manufacturer. That is a thing of the past. Each company manufactures products in several fuel lines—such as oil and electricity—as well as gas. Very few, very small ones are still working purely on gas-fired products.

Let me talk about the types of research that we consider relevant. The discussion usually goes in terms of commercialization which involves short-term and long-term high risk. I do not think that these parameters are as relevant to us as they may be in other areas. Rather, I think our real interests can be divided in a different way. Naturally, companies are interested in, let's call it type 1 research, which entails the development of new products and previously unused technologies. This is in the area which is usually proprietary to the companies.

The second, type 2 research, involves the development of basic information on how things work. Examples of this type of research include studies of a duct system's effect on a bulding's heating efficiency, or the effect of where a heating unit is located within a structure, or how people use their thermostats and why. A particularly relevant example at this time involves an examination of what can we expect from the range of gas mixes that will come out of the end of the pipe as different new ingredients other than pure natural gas go into the transmission lines. What kind of flexibility are the products that our manufacturers make going to have to have in order to handle the variations of ingredients that they may have to deal with?

These are all examples of an area where there is a need for collective research—and this is where the industry needs help. This is almost like your high-risk, long-term future, but it is right now because it is an integral part of the industry's ability to go forward and address the problems that they are facing at the present time.

This is a logical area for joint research and the Justice Department has come forth with some guidelines that make it helpful, make it easier to know what joint research you can do and what you can't. However, the problem we find in trade associations is that it is awfully hard to get everybody in an industry to go back to their home office and seek financial contributions for a joint project. In every corporation there is someone making a decision as to whether you get some funds or not. So it is very hard to get a joint research project going.

Usually, I think this is an area where funds that are made available through another source could be very helpful to the industry: To get them going and over the initial hurdle.

Now, we need to look at the steps in research and organize them into three phases. The first one is to find the funds. This can be very difficult. I am talking about where are the funds—other than the company's—going to come from?

We are looking at Federal grants in the past. We are looking at situations such as the Gas Research Institute and the Electric Power Research Institute, where they can get some funds from the utilities in order to set up research programs.

The second step is deciding how to use the funds.

Now, this is a real problem which involves obtaining direction from the manufacturers who are closest to the actual perception of needs.

In the trade association, we receive a lot of phone calls asking us for this information. Various government contractors call, saying that they are supposed to find out where research is necessary, and ask us to tell them where it is necessary. And we give the same speech over and over again, saying first, we cannot tell you with great ease exactly where the research needs are, because a lot of this research has been going on in the individual corporations for many years. Some of these projects have been brought up to a point where a company realizes that commercial viability is doubtful at this time or perhaps at a later time. There are also stumbling blocks affecting the whole process, such as safety and other problems of actually manufacturing such a device.

So we suggest that they don't just assume because they do not see anything out there, that there is a vacuum. There may be companies who have been working in this area, who may be ready to go with that project in a year or so and would very much resent the fact that you are now trying to publicly provide funds to the rest of the industry on a development they have spent the last 10 years trying to perfect.

So, therefore, it is very difficult for us to advise an inquirer as to where some research might be needed.

Now as a lawyer for a trade association, in-house counsel, I am also attuned to the fact that I do not want our association to be suggesting areas of research that may be of value to one company for whom that research may constitute a missing link that would give them a quantum leap, whereas, if we directed them to another area of research, it may constitute a missing link for another company.

So the suggestion we make is, "We will put out your question to everybody and let anybody who has any ideas come back to you."

The problem with this is that those people in industry who have the knowledge as to where the research should be done are not about to tell their competitors or the rest of the world.

An additional problem that we often run into is the research contractor who asks "Can you organize a meeting for me? Let's get everybody in the industry into one room and let us pick their brains, and we will come up with some good information."

Our response is, first of all, the company won't let the people who are that knowledgeable go to the meeting for fear they will say something; if they do let them go, it will be with instructions not to tell anything, just listen. So what do you have?

I have come to the conclusion on my own and offer this suggestion to a number of inquirers. We will help you identify companies that are probably knowledgeable in the area you are exploring. Contact them and try on a 1-to-1 basis in their home offices, possibly with their lawyer sitting in, to discuss this subject. Your chances of getting a little closer to some real information are better there than in an open forum.

Now the only trouble with this suggestion is that you find the contractors have limited funds. They have $10,000 or $50,000 for a project, and they do not want to spend the transportation cost and the time going around to different association people. They want it all in one place. It cuts down their costs and shows a bigger profit for the project.

Therefore, you have a built-in inability to get the information from the people that have it, through the existing system of contracting out and subcontracting—which is the basis for most of the work that we see getting done.

The third important aspect of research, and it has been alluded to before, is in the monitoring process. The problem is knowing how to abort, and eliminating the fear of aborting a project.

In the whole process, I think the most important aspect that the Government should address is the problem of making it possible to respectably abort a research project. And many of you in Government know that the problem is that you want to keep the project going because the funds are there—and if you cut back the funds, you won't get them next year.

We all need an honorable way, without penalty, to abort, that would let the funds be used for something else that has come up which is more important. The problem is that when a proposal is made, funds get allocated about 2 years or more ahead of time. Thus, the need for some immediate information has no way of getting into that process.

But if you had a way of aborting projects that are not working, and using that money for those things you perceive you really need, then I think we could get done what ought to be done.

Just briefly, the participants in the research process include the manufacturers who we suspect have the greatest knowledge; the utilities and distribution companies who are doing some research on their own, usually for their own geographic needs; the collective energy-supplier research organizations, such as GRI and EPRI; and also the Federal Government, which puts out some contracts through DOE, HUD, or other Government agencies. The bottom line here is what should the Government's role be?

I think the main element of its role is to provide a mechanism to raise funds. Corporations cannot just go to the public and say, "Give us money." The Government is able, in various ways, to gather funds from general taxes or through the tax on the energy user.

Now, our suggestion is that the Government should be limited to two roles: a fundraising role and a monitoring role involving overall responsibility for keeping track of what research is being done.

This role of keeping track of research, if it were centralized, would provide an opportunity for some accountability of where money is being spent. At the present time, there are an awful lot of people running around Washington trying to keep track of what is going on. It is a very tough problem. Also, if you had a centralization of the overall accounting of what is going on, you would have an opportunity to see the relative priorities of Federal spending. Is it spent in gas research, electric, nuclear? You would have a better fix on that.

Our association, the people that we work with, feels that there is a need to focus on organizations such as GRI and EPRI and allow them to become the administrators of any research dollars. Such a role is appropriate since they are a lot closer to the manufacturers and utilities; and without the interjection of a Government structure, they have a better chance to get the work defined that has to be done and to actually get it going.

I sympathized with the Department of Energy when they tried to set up minimum efficiency standards for the appliance industry. They put out a lot of research projects and came out with a document that was very thick [indicating]. I believe it was universally condemned by the industry because it never really got a handle on the real world in which the manufacturers are operating.

The worst example that I heard of came from one of our members who received a call from a beltway bandit contractor. His question was: "How do we build a more efficient oven?" So our member told him how to build a more efficient oven. The contractor said, "Thanks," but our member added, "I have to tell you one thing, it may be more efficient but it won't cook." The unfortuante thing was that the contractor responded, "I don't care, my contract is to recommend how to build a more efficient oven."

The real need that we perceive is for flexibility. The ability to set up a slush fund for the projects that have to be done as the industry progresses in its effort to develop more energy-conserving products; products which they perceive the public is ready to purchase.

In the 1970's, the industry made a major effort to make safer products. In the 1980's, greater energy efficiency is an added goal. To achieve this goal, the availability of research funds to overcome hurdles in a timely fashion is the one area where some real good could be done.

Thank you.

[The prepared statement of Mr. Langmead follows:]

STATEMENT

BEFORE THE

CONGRESSIONAL RESEARCH SERVICE

FEBRUARY 11, 1982

BY

JOHN P. LANGMEAD

VICE PRESIDENT AND DIRECTOR OF TECHNICAL SERVICES

GAS APPLIANCE MANUFACTURERS ASSOCIATION, INC.

gama NEWS

GAS APPLIANCE MANUFACTURERS ASSOCIATION
1901 NORTH FORT MYER DRIVE, ARLINGTON, VIRGINIA 22209

Contact: Charlotte Quinn Phone: 703/525-9565

Biographical Sketch

JOHN P. LANGMEAD

John P. (Jack) Langmead, vice president of the Gas Appliance Manufacturers Association since 1979, became director of its technical services in 1970. He is responsible for coordinating and representing GAMA members' interests in standards, appliance and equipment testing, regulations, codes and related technical matters, and for keeping them advised of the revisions to voluntary standards and federal and state regulations. In carrying out this responsibility, he is a member of two ANSI standards management boards, several committees of the American Society for Testing and Materials, National Fire Protection Association, American Society of Mechanical Engineers, American Society of Heating, Refrigerating and Air Conditioning Engineers and Air Pollution Control Association.

Jack came to GAMA after 13 years' experience as an engineer at the Laboratories of the American Gas Association in Cleveland. He became familiar with the standards and contemporary domestic gas appliances and equipment and learned production techniques including the tooling process and quality control procedures of most gas appliance and equipment manufacturers located east of the Rocky Mountains. While at A.G.A., he worked with the ANS Committee Z21 and its subcommittees (for domestic gas appliances and accessories) and as administrative secretary of the ANS Committee Z83 (for industrial equipment).

He received his education in civil engineering at Purdue University and Ohio State University. Jack and his wife, Patti, have three children.

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THANK YOU FOR THE OPPORTUNITY TO PARTICIPATE IN THIS PANEL.

SO THAT YOU WILL KNOW WHERE GAMA FITS IN THIS ENTIRE PROCESS, LET ME BRIEFLY DESCRIBE GAMA AND WHAT IT DOES.

BACKGROUND ON GAMA

GAMA IS A NATIONAL MANUFACTURER'S TRADE ASSOCIATION REPRESENTING THE INTERESTS OF THE MANUFACTURERS WHO PRODUCE OVER 90% OF THE GAS APPLIANCES AND EQUIPMENT SOLD IN THE UNITED STATES. GAMA IS DIVIDED INTO 13 PRODUCT DIVISIONS, EACH OF WHICH OPERATES MUCH LIKE A SEPARATE TRADE ASSOCIATION UNDER THE ADMINISTRATIVE UMBRELLA OF THE LARGER ASSOCIATION. ON THE RESIDENTIAL SIDE, WE HAVE DIVISIONS SUCH AS THE FURNACE DIVISION, THE WATER HEATER DIVISION, AND THE RANGE DIVISION. ON THE COMMERCIAL AND INDUSTRIAL SIDE, WE HAVE AN INDUSTRIAL HEATING DIVISION, AN INFRARED DIVISION AND A FOOD SERVICE EQUIPMENT DIVISION. WE HAVE A CONTROLS DIVISION, THE MEMBERS OF WHICH SELL CONTROLS TO THE MEMBERS OF THE OTHER DIVISIONS. WE ALSO HAVE ANOTHER DIVISION CALLED THE GENERAL EQUIPMENT DIVISION. THIS DIVISION REPRESENTS MANUFACTURERS OF EQUIPMENT, MACHINERY, SUPPLIES AND MATERIALS, ENGINEERING AND TECHNICAL SERVICES USED IN THE TRANSMISSION AND DISTRIBUTION OF FUEL GASES. MEMBERS OF THIS DIVISION INCLUDE COMPANIES SUCH AS ROCKWELL INTERNATIONAL, THE SINGER COMPANY, DRESSER MANUFACTURING AND T.D. WILLIAMSON COMPANY, ETC. THE ONE THING IN COMMON IS THAT ALL THE MEMBER COMPANIES OF THE GENERAL EQUIPMENT DIVISION SELL PRIMARILY TO GAS UTILITIES AND TRANSMISSION COMPANIES.

BECAUSE OF THE VOLUME OF PRODUCTS SOLD AND BECAUSE OF THE COMMON NATURE OF PROBLEMS FACING GAMA RESIDENTIAL TYPE PRODUCT DIVISIONS, OUR ACTIVITIES OVER THE PAST FEW YEARS HAS BEEN DOMINATED PRIMARILY BY PROBLEMS RELATED TO THOSE DIVISIONS.

I MIGHT ALSO POINT OUT AT THIS TIME THAT THERE IS NO SUCH THING AS A GAS APPLIANCE MANUFACTURER. THERE ARE ONLY MANUFACTURERS WHO PRODUCE THESE APPLIANCES. VIRTUALLY 100% OF THESE MANUFACTURERS ALSO PRODUCE OIL-FIRED EQUIPMENT AND ELECTRIC APPLIANCES. BECAUSE OF THIS FACT, AND BECAUSE OF THE NEED FOR REPRESENTATION IN WASHINGTON, THE GAMA WATER HEATER DIVISION REPRESENTS THE INTERESTS OF ELECTRIC AND OIL WATER HEATER MANUFACTURERS IN ADDITION TO GAS WATER HEATER MANUFACTURERS BECAUSE,IN FACT,THEY ARE THE SAME COMPANIES. ON THE FURNACE SIDE, THE GAMA FURNACE DIVISION REPRESENTS THE INTERESTS OF OIL FURNACE MANUFACTURERS IN ADDITION TO GAS. AGAIN, BECAUSE THEY ARE THE SAME COMPANIES. UNTIL RECENTLY, WESTINGHOUSE ELECTRIC CORPORATION WAS A MEMBER OF GAMA UNTIL IT SOLD ITS HEATING AND AIR CONDITIONING DIVISIONS TO BORG-WARNER WHICH ALREADY WAS, AND STILL IS, A GAMA MEMBER.

TYPES OF RESEARCH

WITH THAT AS BACKGROUND, LET ME MAKE SOME SIMPLE OBSERVATIONS ABOUT RESEARCH WHICH WILL LEAD TO A ROLE THE FEDERAL GOVERNMENT MIGHT PLAY TO INSURE THAT NOT ONLY INDUSTRIAL, BUT ALL ENERGY CONSERVATION EFFORTS PROCEED ON A SATISFACTORY SCHEDULE. FIRST, THERE ARE SEVERAL DIFFERENT TYPES OF RESEARCH AND DEVELOPMENT. LET ME BREAK THESE DOWN SIMPLY INTO WHAT I WILL REFER TO AS TYPE 1 AND TYPE 2 RESEARCH. I WOULD DEFINE TYPE 1 RESEARCH

AS THE DEVELOPMENT OF NEW PRODUCTS, OR PREVIOUSLY UNUSED TECHNOLOGIES. THIS WOULD INCLUDE THE DEVELOPMENT OF MORE EFFICIENT EQUIPMENT, STRUCTURES OR PROCESSES. VERY OFTEN THIS TYPE OF RESEARCH LEADS TO A PATENTABLE DESIGN AND A PRODUCT OR PIECE OF EQUIPMENT WHICH CAN BE PRODUCED FROM WHICH ROYALTIES CAN BE DERIVED. THESE ROYALTIES CAN THEN BE USED FOR ADDITIONAL RESEARCH. TYPE 2 RESEARCH IS THE DEVELOPMENT OF AN UNDERSTANDING OF THE EXISTING SITUATION. THIS TYPE OF RESEARCH LOOKS AT SUCH THINGS AS THE EFFECT OF THE DUCT DISTRIBUTION SYSTEM ON A BUILDING'S HEATING SYSTEM EFFICIENCY. IT ALSO LOOKS AT THE EFFECT OF A HEATING UNIT'S LOCATION WITHIN THE STRUCTURE. IN THE HUMAN SCIENCES, IT INCLUDES RESEARCH TO DETERMINE EXACTLY WHY CERTAIN PEOPLE DO CERTAIN THINGS. FROM AN ENERGY CONSERVATION POINT OF VIEW, THIS INCLUDES WHAT THEY WILL DO TO A THERMOSTAT AND UNDER WHAT CONDITIONS.

CONDUCT OF THE TYPE OF RESEARCH WHICH I HAVE DESCRIBED IN TYPE 2 VERY SELDOM LEADS TO A PATENT AND THUS THE PRODUCTION OF EQUIPMENT PRODUCING A ROYALTY.

THE BENEFITS OF SUCH RESEARCH ARE NOT READILY VISABLE TO EVERYONE PAYING FOR THAT RESEARCH, BUT IN FACT IF PEOPLE WOULD STOP AND THINK, WITHOUT THE CONDUCT OF TYPE 2 RESEARCH, THE CONDUCT OF TYPE 1 RESEARCH CANNOT BE EFFECTIVELY DIRECTED. YOU FIRST HAVE TO KNOW WHAT THE PROBLEM IS BEFORE YOU CAN DEVELOP A SOLUTION. TYPE 2 RESEARCH DEFINES THE PROBLEMS, TYPE 1 SOLVES THEM.

STEPS IN RESEARCH

LET ME NOW IDENTIFY A FEW OF THE DIFFICULTIES ASSOCIATED WITH RESEARCH AND DEVELOPMENT. THE FIRST DIFFICULTY IS FINDING THE FUNDS TO DO WORK. THE SECOND IS ESTABLISHING EXACTLY WHAT SHOULD

BE DONE SO AS TO USE THOSE FUNDS WISELY. THE THIRD IS TO MONITOR THE PROGRESS OF THE R & D PROJECT CAREFULLY SO THAT IT CAN BE TERMINATED IN A TIMELY FASHION IF IT APPEARS THAT IT WILL NOT PRODUCE POSITIVE RESULTS. WE ALL KNOW THAT R & D EFFORTS ARE NOT SUCCESSFUL EVERY TIME. AS A MATTER OF FACT, IF YOU CAN FIND AN R & D FIRM WHICH PRODUCES A SUCCESSFUL MARKETABLE PRODUCT 10% OF THE TIME, I WOULD LIKE TO KNOW THE NAME OF THAT FIRM, SO I CAN INVEST IN IT. BY TERMINATING DEAD END PRODUCTS AT THE APPROPRIATE TIME, MORE RESOURCES CAN BE CHANNELLED TO PRODUCTS HAVING MORE POTENTIAL.

AN EXAMPLE OF THIS IS WHAT HAS BEEN DONE IN THE AREA OF SOLAR RESEARCH. MONEY HAS BEEN THROWN AWAY AT ALMOST EVERY TYPE OF SOLAR RESEARCH PROJECT IMAGINABLE. THIS PROCESS LIMITS TO A GREAT DEGREE, THE AMOUNT OF MONEY WHICH CAN BE SPENT ON THE PROJECTS WITH THE HIGHEST POTENTIAL FOR SUCCESS.

PARTICIPANTS IN APPLIANCE R & D

IN EXAMINING THE FEDERAL GOVERNMENT'S ROLE IN THE R & D AREAS, I THINK IT IS ALSO IMPORTANT TO IDENTIFY THE OTHER PARTICIPANTS IN THE R & D GAME. IN THE AREA OF ENERGY CONSERVATION, I THINK THERE ARE FOUR MAJOR PARTICIPANTS AND I WILL LIST THEM IN ORDER OF CONTRIBUTION IN THIS EFFORT. FIRST, THERE ARE MANUFACTURERS OF APPLIANCES AND EQUIPMENT WHICH DO THEIR OWN CLOSELY HELD AND HIGHLY PROPRIETARY R & D. THEY DO NOT SHARE THIS INFORMATION UNTIL THE PROJECT HAS BEEN COMPLETED AND A MARKET ADVANTAGE GAINED. SECONDLY, THERE ARE ENERGY SUPPLIERS. THESE INCLUDE BOTH GAS AND ELECTRIC UTILITY AND DISTRIBUTION COMPANIES. THEY DO

SHARE SOME OF THEIR RESEARCH KNOWLEDGE, BUT THEIR FOCUS IS PRIMARILY ON PROJECTS NEEDED FOR THE GEOGRAPHICAL AREAS WHICH THEY SERVE. THIRDLY, THERE ARE THE COLLECTIVE ENERGY SUPPLIERS RESEARCH ORGANIZATIONS. FOR THE GAS INDUSTRY, THE ORGANIZATION IS THE GAS RESEARCH INSTITUTE. FOR THE ELECTRIC INDUSTRY, IT IS THE ELECTRIC POWER RESEARCH INSTITUTE. BOTH OF THESE ORGANIZATIONS RECEIVE THEIR FUNDS FROM ENERGY USERS AND UTILIZE UTILITY COMPANIES AS THEIR COLLECTION AGENCIES. WE PAY FOR THEIR EFFORT IN OUR MONTHLY GAS BILL AND ELECTRIC BILL. IN THE CASE OF GRI, FERC REVIEWS AND ANNUALLY APPROVES THEIR OPERATING PLAN. THE FOURTH PLAYER IN THE RESEARCH GAME IS THE FEDERAL GOVERNMENT. IT INCLUDES THE FUNDS DERIVED FROM DOE, HUD AND OTHER GOVERNMENT AGENCIES WHICH ARE LET OUT IN THE FORM OF CONTRACTS TO THE NATIONAL LABORATORIES OR TO AN INDEPENDENT RESEARCH ORGANIZATION (FONDLY REFERRED TO BY THE APPLIANCE COMMUNITY AS BELTWAY BANDITS.)

RESEARCH ROLE OF GOVERNMENT

I AM SURE ALL OF US HERE TODAY THOROUGHLY RECOGNIZE THE NEED FOR RESEARCH AND DEVELOPMENT. OUR COUNTRY'S FUTURE DEPENDS ON DOING AT LEAST AS GOOD A JOB IN THIS AREA AS IS BEING DONE ANYWHERE IN THE WORLD. OUR RESEARCH EFFORT HAS BEEN CRITICIZED BY MANY AS BEING SHORTSIGHTED. PERHAPS IT HAS BEEN IN SOME CASES, BUT I BELIEVE THIS SHORTSIGHTEDNESS IF THE RESULT OF OTHER PROBLEMS. IF YOU CAN'T MAKE ENOUGH PROFIT TO STAY IN BUSINESS OVER THE SHORT HAUL, LONG RANGE R & D WILL NOT BE USEFUL. WHAT WE NEED IN THE R & D COMMUNITY IS STABILITY. A PROCEDURE AND ASSOCIATED FUNDING MECHANISM WHICH DOES NOT CHANGE EVERY COUPLE OF YEARS AND GETS

TRANSFERRED FROM ONE GOVERNMENT AGENCY TO ANOTHER. TO GET THE BEST RESULTS AT THE LOWEST COST, THE NATION'S R & D EFFORT CANNOT BE DIRECTED BY ELECTED GOVERNMENT OFFICIALS. IF THOSE OFFICIALS RECOGNIZE THE NEED FOR R & D, THEY OUGHT TO RECOGNIZE THAT IT IS THE TECHNICAL COMMUNITY WHICH HAS THE BEST CHANCE OF ALLOCATING R & D FUNDS SO THAT THEY WILL PROUDCE THE GREATEST VALUE. TO GAIN STABILITY IN OUR R & D EFFORT, I WOULD SUGGEST THAT GOVERNMENT'S ROLE IS RELATIVELY SIMPLE. THAT ROLE SHOULD BE 1) TO PROVIDE MECHANISMS WHERE FUNDS WHICH CONDUCT R & D CAN BE RAISED, AND THEN LET THE ENERGY SUPPLIER RESEARCH ORGANIZATIONS SUCH AS GRI AND EPRI DECIDE HOW TO SPEND THOSE FUNDS AND ON WHICH PROJECTS FUNDING SHOULD BE STOPPED. IT IS THE MANUFACTURING COMMUNITY THAT HAS THE MOST KNOWLEDGE OF WHERE R & D MONIES SHOULD BE SPENT. THEY USE THIS KNOWLEDGE THEMSELVES. THEY TRANSMIT SOME OF THIS KNOWLEDGE TO, AND WORK WITH, THE RESEARCH EFFORT CONDUCTED BY VARIOUS UTILITY COMPANIES. WE ARE DEVELOPING AN IMPROVED INPUT INTO THE RESEARCH EFFORTS OF GRI AND EPRI. HAVING THE FEDERAL GOVERNMENT PLAY A ROLE DECIDING WHERE RESEARCH FUNDS SHOULD BE SPENT ONLY ADDS A DUPLICATIVE LAYER ON THIS DECISION PROCESS. NO ONE KNOWS FOR SURE WHERE THE R & D FUND GAME IS BEING PLAYED. MANY SPEND A LOT OF TIME AND EFFORT TRYING TO FIND THE STADIUM WHERE THE R & D GAME IS BEING PLAYED. SOMETIMES THE GAME IS OVER BEFORE THEY ARRIVE. THE BEST PROCEDURE FOR AWARDING AND MONITORING RESEARCH FUNDING IS LIKE MOST OTHER THINGS -- THE SIMPLER THE STRUCTURE, THE BETTER. THE DECISION-MAKING STRUCTURE ALREADY EXISTS WITHIN GRI AND EPRI. LET'S USE THAT STRUCTURE AND FOCUS THE NATIONAL EFFORT IN THIS DIRECTION. THE LAWS AND REGULATIONS covering funds which can be raised by GRI and EPRI are already in place. They should be encouraged and their funding should be expanded. Energy users would then be paying for energy related research. Some may be concerned that this puts a disproportionate burden on the poor. I am not sure of the validity of this argument since the poor do use significantly less energy than the wealthy and in fact, when you look at gas, oil and electric consumption, industry uses the lion's share.

An additional means for increasing the funds available for GRI and EPRI direction would be to funnel any direct federal grants that the Congress may be inclined to recommend -- through these organizations. The federal government's role in monitoring R & D should be that of an audit accounting process to keep track of the dollars being spent. At the presnt time, there is a great inequity in federal R & D funding as it related to the areas of electric generation and utilization vs. gas, oil, coal or renewable energy distribuiton and utilization. Centralizing the federal accounting process should result in fairly proportioning the funds to various forms of energy research depending on the country's long range needs and in particular, to reduce our dependence on foreign oil.

In summary, my proposal to you is to consider a program for R & D which is in fact a single national program because of the federal government's accounting role, but which in fact works very much like the new "federalism" approach proposed by our President for handling entitlement programs. Increased user revenues

AND CONGRESSIONAL FUNDING, IF ANY, SHOULD BE DIRECTED TO THE EXISTING NON-GOVERNMENTAL NATIONAL RESEARCH ORGANIZATIONS SUCH AS GRI AND EPRI TO PUT THE DECISION PROCESS AS TO WHERE FUNDS ARE SPENT IN THE HANDS OF THOSE WHO KNOW HOW TO MANAGE RESEARCH AND DEVELOPMENT PROGRAMS, THAT IS, THE PEOPLE INVOLVED IN R & D. HAVING A SINGLE NATIONAL ACCOUNTING FOCAL POINT FOR THE USE OF NATIONAL R & D FUNDS WILL ALLOW EVERYONE PLAYING THE R & D GAME TO KNOW WHERE THE GAME IS BEING PLAYED AND WITH THAT INFORMATION, THEY CAN FIND OUT THE RULES OF THE GAME AND AT WHAT TIME IT STARTS. THIS ALONE WOULD SAVE ENOUGH MONEY TO SIGNIFICANTLY INCREASE OUR R & D EFFORTS.

THANK YOU.

RECOMMENDATION

Government's Role

1. Funding -- Provide "mechanisms" whereby funds to conduct R & D can be raised for
   a) R & D done by supplier research organizations (SRO) such as the Gas Research Institute (GRI) or the Electric Power Research Institute (EPRI).

   b) R & D directed to other private or federal research organizations -- through the SRO's in order to coordinate programs.

2. Project Accounting Control -- Act as repository of SRO and other research organizations' reports on their activities.
   a) Let SRO's decide
      i. which projects to undertake.
      ii. how research done.
      iii. when to abort, if necessary.
      iv. disposition of unused funds --
         A. to other existing or new projects.
         B. saved for later use or turn back.

   b) SRO accounting -- periodically or after use of funds -- not before
      i. description of activity should be adequate to allow public to understand project.

      ii. threat of jeopardizing future funding would prevent misuse of funds.

      iii. government staff second-guessing in advance would be avoided.

ADVANTAGES OF RECOMMENDATION

1. Decisions made with manufacturing community input which has best knowledge of where long-range energy use R & D money would be useful.

2. Everybody would know where R & D is taking place, not scattered all over. Facilitates government and private sector monitoring and evaluation of long-range R & D activity as it relates to energy conversion equipment that will be sold through our free market system to end users.

3. Fair proportioning of funding will be enhanced if ultimate accounting of all funding is centralized.

Dr. CRANE. Thank you.

I hear a number of conflicts being voiced here between proprietary matters within companies and the national interest.

I also hear in my own mind—as I interpret the comments that are made—a great deal of uncertainty about markets, whether a market really exists or not. When a company begins to develop a product, its saleability might demand institutional changes, production changes, or changes on the part of consumers. There are great question marks, therefore, surrounding what can be developed.

I would like to ask Donald Collier, who gave us a set of criteria and methods for developing new energy technologies, how he perceives that a demand market can be created for some of these technologies? Some of the things you said are very parallel to what NASA's situation was in creating their hardware. In that case the market was clear. In this case we have a very indefinite market, it is indistinct and problematical.

Would you care to comment on that?

Dr. COLLIER. I think in the case of NASA and Defense, you do have a clear market because the Government is the customer. And research supported by the Government has been fairly successful in those areas.

The customer here is the consumer. The industrial companies are the generators of the products that are sold to the consumers. And it is a high-risk process, as our friends in the automobile companies found out.

The suppliers are the same, they get the backlash of it, but that is what we are in business for.

Now the point that you alluded to where a piece of technology is really an energy breakthrough but requires a structural change in the user to apply it, is a very high-risk thing. And I think that accounts for the difference between the so-called social value of research, which George referred to and is promoted by Mansfield, and the private value of research.

Actually, I think the difference is a measure of the total social costs of having to rearrange the structure in order to utilize an energy device. If you look at it that way, there is no dichotomy that says the industrial company won't engage in it because they cannot see enough returns coming to them. There is a real cost involved in changing the economy in order to utilize it, and therefore you can approach it two ways.

I think your slide comparing the utility's benefit from using the superconductor generator with the returns for the industry is an example of this. If you price the superconducting generator such that the value in use to the utility was the same as its present best alternative, you would get your money back in a great hurry. So, what you have to do is sit down and trade with the utility and say: "Look, I need part of it, you are going to get part of it, let's see if we can arrive at an equitable sharing of this big gap between best-present technology and this future technology."

Dr. **Mechlin**. The history has been that the trade is taking place to the advantage of the utilities.

Dr. **Crane**. They are the customer, they determine the price.

Dr. **Mechlin**. Parenthetically, I might add, I had many examples of that in some recent congressional testimony; I used the ceramic gas turbine as an example. Our company discontinued development work on it for exactly this reason: There was no prospect of getting back our research and development costs in any prospective sales.

Mr. **Harvey**. I have several comments to make on your statements.

First of all, how do you get into a project? And how do you assure that getting into a project from the Federal Government's standpoint is not going to duplicate the private sector's unassisted activities? One of the ways is to evaluate the probability of failure of a given project and adjust the cost sharing; I firmly believe in cost sharing because of another problem.

By evaluating the probability of failure, you can come up with a pretty good estimate as to whether or not a private company would, indeed, embark upon a research and development program of a given nature. But the other point that I want to make is, and it was brought up by two of the speakers, when do you get out of a project? That is just as critical as getting into a project. Cost sharing helps.

I can cite some examples of projects that needed a bail out provision. For example, Union Carbide once had such program arrangement with DOE to develop a catalytic converter. Technically, the program was indeed successful, but it turned out it could not be an economically viable alternative for methane production from those activities that produced a lot of carbon monixide, like carbon black and so on.

Union Carbide came to us when I was with the Department of Energy and said: "We do not think it is going to work and because we have a pretty good stake in this program, we think it ought to be abandoned."

We abandoned that program. That is the logical way of determining when programs should be abandoned. If you have critical milestones within a program, they are the points at which you evaluate critically all the parameters to check the economic and technical viability of the program. This constitutes a mechanism for abandoning the project.

On the phosphoric acid fuel cell, I could not agree more, that program should probably never have been entered into by the Department of Energy.

Mr. SHELDON. George, I was wondering on your chart there where you were showing, I believe, relative changes in energy consumption by residential, commercial, and industrial sectors—you showed no change for industry. I think it was misleading because the fact remains that the industrial portion of the total U.S. energy consumption was around 45 percent; it is now down around 35 percent.

Dr. MECHLIN. That was per unit of output?

Mr. SHELDON. No; gross use of energy. Gross use of energy today is around 35 to 36 percent in the industrial sector. It was previously up closer to 45 percent.

Dr. MECHLIN. In terms of per unit of output?

Mr. SHELDON. If you look at per unit of output, my recollection is that it is even more pronounced than a reduction from 45 to 35 percent.

Dr. CRANE. That is interesting.

Mr. BURNS. I was going to comment that the Department of Energy's Industrial Programs Office used a fairly rigorous method of calculation to report that in 1979 industry used 15.3 percent, I think, less energy per unit of production. They have not published a 1980 figure yet, but it is higher.

Dr. MECHLIN. Let me return to the point.

The point is not that it has not been falling; it has been falling. I think the point here is that it did not in fact respond to any kind of a discernible change in the improvement trend. It says whatever factors were limiting industrial investment on an aggregate basis did not change. So, the rate of investment apparently stayed constant.

As a manufacturer of that kind of equipment, if you see no rate of change you have to conclude there is no new market. There may be a market, but it is not a new market. There is no increment on top of what you had previously experienced.

Mr. SHELDON. I think the general area where there was a drastic change involved equipment that you do not manufacture.

Dr. MECHLIN. No, these are statistics of the Federal Government.

I will make one other comment here. We have in this room a very unrepresentative collection of companies. These are technically capable, high technology companies. In those sectors there have probably been differences from that trend. But in the aggregate statistics, there are many, many other energy consumers who do not fit that prescription of technically sophisticated, economically capable organizations. You cannot judge the U.S. industry by the performance of a General Motors or Alcoa.

Mr. SHELDON. I was looking at the DOE numbers which have been released over the last 8 years. That is not what we have seen.

Mr. SHERRY. I am not sure, but I would like to see if the statistics from the Department of Energy are based on units of energy per unit of output as a physical measure, whether the output measure is units, volumes, tons, and so forth.

The Westinghouse figures are based on energy use relative to the value of the output in dollars. Since there has been such a recession going on, we cannot get increased prices for the product; you can get those two statistics going in different directions. You can get improvement in unit of volume but if you cannot get any price increase, you do not get any improvement on a monetary basis. I think that is the reason.

I think your numbers are probably based on value of the output, the other numbers are based on the specific units of output.

Dr. **FRANKEL**. I would like to ask Dr. Collier to go through his proposal one more time for me and to do it both for research conducted within a Government laboratory and for research conducted in a private laboratory. What exactly is the mechanism you are talking about? You explained it, but I did not quite get it.

Dr. **COLLIER**. The proposal is aimed primarily at research done in isolation from the industry who will cause the rest of the innovations to take place. That is, research done by Government laboratories, universities, or research institutes.

You have two mechanisms, I think, where the performer of the research is the supplier industry. You could use this mechanism or, as the other speaker said, use cost sharing as a way of getting at it.

The proposal is that the unit wanting to support this research would write up the project with how much it is going to cost, how long it is going to take, and what the result will be if it is technologically successful.

You put that out for bids just like you put out oil leases. The potential supplier industry would bid for exclusive use of the results of that R&D, if it is technologically successful, in the form of a down payment and a committed minimum royalty and a running royalty so that they cannot just put it on the shelf if it is successful. They have to pay a minimum royalty.

And if you do not get bids which look as though they will at least return the cost of performing the R&D, that is a message that the industry, who is close to the market, does not think that that technological result is really economically attractive, so you do not do the research.

Dr. **CRANE**. Are there further questions?

Mr. **SHEAHEN**. I have a question I am going to ask Mr. Daley based on something Mr. Gamze talked about.

We have been scooped in America several times by inventions made by Americans that somehow or other disappeared into the closet and came back to us from overseas. For example, I am thinking about the stratified-charge engine that Honda made, which gets somewhere in the mid-30's on gasoline mileage, whereas the American cars, to meet pollution rules, went down the path of the catalytic converter. With hindsight it does appear that the market, including America, will accept the stratified-charge engine.

Here is the question: With hindsight, is there anything that could have been done differently in the United States—looking back now to the 1960's and its earliest development up to the present—that would have made benefits of this American invention accrue to American companies?

Mr. **DALEY**. Let me qualify first that I am not an engine expert. I have been close to some of this work. A great deal of work was done within my company on the variety of engines available.

Compared to Honda, for example, there were a lot of differences in the families of sizes of engines. I am told that makes quite a lot of difference in the acceptability, performance, cost, and capability of these different varieties of engine.

Ford had a very extensive program on this, too. And at the time, in the framework of the engine mix that was under consideration this one did not come out from the standpoint of the best efficiency in terms of both the manufacturing cost of the engine and its performance in terms of both economy and emissions. So it was laid aside in favor of something that was considered to be more practical, a sure thing.

I think this is another area where you encounter some of these considerations. Covering the overall range, including totals of production, variables in production, and other factors that are considered; the developmental factors at the time these engines were reviewed within our company did not indicate the necessary degree of favor and so a different course was chosen.

I think it is a matter that might even be related to the comment made about the 8-6-4 engine. Some of these technologies look different in retrospect than they did going in. However, at that time we felt there were a lot of factors of variability, size of engine, and overall economy of manufacture that made the stratified charge engines unattractive.

The smaller engines are, I think, quite clearly easier to make behave in this respect and at that time we were looking at a different mix.

Dr. Crane. I think we had better terminate questions at this point because lunch is coming up. Before you leave, the other speakers will be joining us on our walk to the Madison Building.

The third panel will convene at 2 o'clock this afternoon. So we hope to see all our participants back here then.

[Whereupon, at 12:45 p.m. members of the seminar recessed, to reconvene at 2 p.m., the same day.]

Afternoon Session

POLICY AND PROGRAMS

STATEMENTS OF HENRI-CLAUDE BAILLY, PRESIDENT, HAGLER, BAILLY & CO., WASHINGTON, D.C.; A. BRUCE BURNS, DIRECTOR OF CORPORATE ENERGY CONSERVATION PROGRAM, UNION CARBIDE CORP., NEW YORK, N.Y.; MARC H. ROSS, LABORATORY OF PHYSICS, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICH., AND REPRESENTING ALLIANCE TO SAVE ENERGY, WASHINGTON, D.C.; EDWARD V. SHERRY, DIRECTOR OF ENERGY SUPPLY, AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA.; AND JOSEPH TRIBBLE, ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY, U.S. DEPARTMENT OF ENERGY

Mr. Sissine. We are honored to have with us this afternoon a very distinguished group of gentlemen for this, our final, panel of the seminar. This panel includes Henri-Claude Bailly, Bruce Burns, Marc Ross, Ed Sherry, and Joe Tribble.

Each panelist will describe what he sees as the most critical policies and programs at both national and international levels for conservation in industry.

I will ask the audience, again, to reserve their questions until after the entire panel is finished.

We hope that the remaining members of the first two panels will join in the question-and-answer period to follow.

Our first speaker will be Henri-Claude Bailly.

Henri-Claude was trained in architecture in Paris, France, and has more recently studied architecture and business administration here in the United States.

He is currently president of Hagler, Bailly & Associates, with offices in Washington, and affiliates in Paris and Tokyo.

He consults with private companies and Government agencies, both in the United States and abroad.

Henri-Claude?

[A biographical sketch of Mr. Bailly follows:]

HENRI-CLAUDE BAILLY

Mr. Henri-Claude Bailly focuses his consulting activities on international resource policy, strategic market planning and technology transfer between Europe and the United States. His clients include many of the major U.S. and foreign industrial energy companies, as well as Governmental agencies here and abroad. Mr. Bailly studied architecture at the Ecole Nationale Superieure des Beaux Arts in Paris, France. His received has BArch and MArch at the University of Washington, and his M.B.A. from the Harvard Graduate School of Business Administration where he held the George Doriot International Fellowship.

STATEMENT OF HENRI-CLAUDE BAILLY

Mr. **BAILLY**. Thank you.

The focus of my brief remarks will be to set the stage for what is happening overseas in 1981 and 1982 and hopefully to provide some insight into how other countries see the role of the public sector in industrial energy conservation.

I will focus my remarks on five countries. Before I go on with the presentation, I would like to preface it by saying that when you do international comparative analysis, you have to be very careful to compare apples with apples.

In looking at the funding for industrial energy conservation in these countries, I used as a framework the mission of the Office of Industrial Programs at the Department of Energy as its mission is currently defined.

As a result, for some countries, I had to eliminate certain programs from the comparison—programs which they consider part of their industrial conservation effort. For instance, Germany's district heating program was not included because in the United States that program would probably have been carried out in another division of DOE, or another agency of the Government.

Often, the first question asked me when I talk about international activities in industrial conservation is: How much money are they spending?

Again, there is a pitfall when you talk about spending; you have to think in terms of the fiscal years used by these countries, and the fiscal cycle varies dramatically from one country to another. France and Germany use the calendar year as the fiscal year; the

United States starts in October; Japan, and the United Kingdom start in April, and the Swedish fiscal year starts in July. In order to compare, you have to put everything on the same basis, so the figures shown here are the 1981 calendar year expenditures of these various countries.

As you can see from the slide, the United States has spent more in absolute terms during 1981 than most other countries—except for Sweden and the United Kingdom, which actually spend a few million dollars more than the United States on industrial conservation.

Japan spends substantially less. In 1981 they spent less than $6 million on research, development, and demonstration activities.

Now, another way to look at the statistics, of course, is to look at the effort each country's government puts in industrial energy conservation. Here you cannot look at absolute scales. You have to look at relative scales.

One way, and an easy way because the statistics are easily available, is to look at industrial output and look at how much each government spends per unit of industrial output.

The United States does not do as well under this type of comparison.

The only other government which spent less than the United States in 1981 was Japan.

Sweden, according to this criterion, spends about 29 times what the United States spends.

Germany spends exactly about twice what the United States spends.

I could also have looked at Government spending per unit of primary energy consumed by the industrial sector. In this case the United States would have been last. Even Japan spends more than the United States per unit of primary energy consumed.

So far, we have been looking at the last calendar year. What will these countries spend in this 1982 calendar year which started a few weeks ago? Let us look at this next slide. I have reviewed these figures with the officials of the various countries, so they are not just my calculation. The Federal Republic of Germany, which has some problems right now, is—like the United States—cutting its public sector expenditure, and because of that, they are just maintaining their 1981 level of RD&D expenditure in the industrial sector.

Some other countries, actually all four other countries, are increasing their funding.

Japan is increasing its spending by $2 million. France's budget is uncertain, but may be as much as $80 million this year; and Sweden and the United Kingdom are increasing slightly their funding—by approximately 10 percent each. That is what is happening overseas.

The next question which I am asked is: How do foreign governments justify their involvement in industrial conservation?

Basically, they look at it mostly as part of the overall thrust to achieve a better balance of payments. In all these countries, foreign trade is a very large component of their economy and their oil import bill is another big component. Therefore, they try to equalize these two components.

They tend to back out oil as much as possible: The focus and rationale for their program is clearly to minimize oil imports. This is true in France, and very, very true in Japan.

The other objective is to maintain or improve the competitiveness of their industrial sector. They want to make sure they remain competitive on a cost basis so they can continue to export their goods. This consideration is especially important in the context of rising labor costs.

To achieve this goal, all of these countries use a three-pronged approach.

Being of European extraction and having lived in the United States over the last 13 years, I am in a position where I can defend the market approach of these countries. There are fewer regulations imposed on the private sectors than there are in the United States. So please block out from your mind the notion that industry in these countries operates under very structured government-mandated initiatives which force them to move in a certain way toward energy efficiency.

All of the countries, except for Sweden, have relied on price in the past as the primary policy instrument to motivate investment in industrial energy efficiency. Energy prices have been traditionally higher in the industrial sectors of these countries and their governments have done very little to try to control energy prices: The faster they moved toward world parity, the better off they were.

That is not to say that the Germans are not subsidizing their domestic coal industry. But, by and large, you can say that the objective has been to let price motivate the industrial decisionmaker.

For many years, all of these governments relied on price as the primary policy instrument in industrial energy conservation. However, since the second price shock of 1979, they have developed and implemented substantial programs in research, development and demonstration to complement the price mechanism.

For example, every single country has an audit program for industry. Furthermore, they have training programs for industry. For instance, even Japan has 4,200 energy control officers in the industrial sector. These positions are mandated by MITI and the officers are on the payrolls of the companies. The whole cost is borne by the private sector, but the entire operation is a requirement imposed by the Japanese Government. Additionally, all of these countries have low interest loans available to the industrial sector for investment in energy conservation. The largest program today is probably the Germans' program: At the end of last year, 6.3 billion Deutsche marks were available at approximately a 10-percent interest rate for companies to invest in energy conservation.

Now, what type of R&D do they sponsor?

Clearly, their focus is on the short-term development of more efficient existing technologies, such as corrosion resistant heat exchangers, and the use of on-the-shelf equipment for new applications. German RD&D is short term as opposed to long term, and I would say only about 20 percent of the budgets go for long-term research. Everything else involves investments in programs which would have an impact in the next 2 to 3 years.

This morning, a question was asked about the criteria used by governments to sponsor or to select projects. All of the countries use the potential for export as a criterion. Actually, some governments, like Germany, sponsor programs in solar, for instance, which are strictly aimed at the export market. Such efforts are underwritten by the government, since the private sector will generally not invest in developing technology for which there is no domestic market.

How do their R&D programs differ from those of the United States?

Mostly they have a longer term view. Through their trade associations, industry participates very early in program definition.

You also see industry on the board of directors of the agencies which decide on which project to fund. All projects are cost shared to increase the scope of commercialization or to accelerate commercialization.

There are no CBD's in these countries, no competitive bids are made, most funding activities involve arm's-length transactions. As for the problem raised this morning about working with a company on a one-to-one basis in order to give it a competitive advantage—that is not a problem, at least it is not perceived as a problem.

One aspect which is very important in my mind is that these programs are all generally oriented toward the small- and medium-sized companies. All the loan programs in Germany, all the technical assistance in Germany and Japan—they are all heavily oriented toward small- and medium-sized companies. I had discussions with representatives of some very large companies, who indicated that they felt this was a totally normal practice. Large companies expect information and a consistent framework in which to operate to be provided by their government.

Based on the work we are doing with private companies in the United States, Japan, and Western Europe, we found that many of the small- and medium-sized companies in the United States are being placed at a competitive disadvantage. I am not talking about the multibillion dollar, multinational U.S. corporations, but the medium-sized companies in the United States for which a $2 million R&D expenditure is a substantial amount of money. These companies are being placed at a disadvantage.

In Germany, the R&D bill might be picked up by the Government, and if you move into a marketing mode, even product promotion might be picked up on a cost-share basis by the Government. If you succeed, you pay them back. If you fail, you are forgiven.

The U.S. technology leadership in some areas, such as mass produced electric components and the use of ceramics in turbines or heat exchangers, is likely to erode. This is also true for some of the process technologies such as dyeing, evaporation, and grinding. We better be careful, because these countries are getting very good at taking a leading role in technical developments..

Finally, I see one other problem developing because so much of an energy efficiency improvement actually transcends energy and goes into general productivity issues. By not giving attention to this issue, U.S. industry, as a whole, might actually suffer. All of the industries in Japan, for instance, have been much more efficient in the past, and they are continuously investing to improve their efficiency.

The Japanese are at the point where they realize that process retrofit will not get them much further and that what they will have to do now is develop brand new processes. This is likely to result in overall productivity improvement and not just energy conservation improvements.

Mr. SISSINE. Thank you.

Our next speaker will be Bruce Burns. Bruce was trained in chemical engineering, and his work for Union Carbide has spanned four decades, taking him from production engineering and rocket propulsion management to his current position as director of energy conservation, which he has held since 1978.

Bruce?

[A biographical sketch of Mr. Burns follows:]

A. BRUCE BURNS

DIRECTOR - ENERGY CONSERVATION
ENERGY AND TRANSPORTATION POLICY DEPARTMENT
UNION CARBIDE CORPORATION

Mr. Burns was born in Gulfport, Miss. in 1920 (Nov. 19). He was graduated from Columbia University with the degree of B.S. in Chemical Engineering in 1941. He also holds the degree of M.S. from Columbia University received in 1942 and M. S. from Massachuetts Institute of Technology (Sloan Fellowship Program) received in 1962.

He joined Union Carbide in 1942 as a production engineer at the corporation's chemicals plant in South Charleston, W.Va. He continued in the chemicals area of Union Carbide's business, moving up to the position of general manager for rocket propulsion in 1962, plant manager at Whiting, Indiana in 1964 and at Institute, W. Va. in 1966. In 1968, Mr. Burns was appointed a vice-president of production in the Chemicals and Plastics Division and became vice-president -- Engineering in 1969. He became manager - energy and feedstock planning in 1964, and has been director, energy conservation, since February, 1978.

Mr. Burns has been active in trade associations and government affairs in the energy area. He has been a member of the Energy Committee of the Chemical Manufacturers Association and has participated in and chaired task groups. He has participated in energy activities with the National Association of Manufacturers, Mellon Institute's Energy Productivity Center, etc. He has given talks at several conferences and has testified before Congressional committees. Mr. Burns is a member of the American Institute of Chemical Engineers.

STATEMENT OF A. BRUCE BURNS

Mr. BURNS. I think I would like to start off with a couple of comments. The first is that I would like to look at the subject very broadly, in terms of what the Government should do to help industry improve the efficiency with which it uses energy. That means I am looking at a little bit broader subject than just the research and development aspect.

The other comment is that when you are on the last panel of the day, it is either an advantage or disadvantage. I have discarded a lot of what I had planned to say, because it would be repetitive of what has already been said. Instead, I will try to add a little bit of a different perspective to what has already been said.

I would like to spend just a moment talking about what industry—and I will use my company as an example—does to accomplish energy conservation. From that framework, we can look at the areas where the Government might help and where its help might not be cost effective.

I would like to point out that prior to the Arab oil embargo, we designed facilities properly for the use of energy. Energy was cheap then, and you could not economically justify large investments in the highly efficient use of energy. This was an economic tradeoff.

I think the same thing is true with our operating and maintenance procedures. We look back now and say, my God, how sloppy we were, but perhaps recognizing the value of manpower and other materials, it may not have been economically inappropriate.

However, with the massive increase in the cost of energy that we have had since late 1973, the world has changed, and it has given us many opportunities to improve the efficiency of energy use.

It has been rather exciting in terms of things that could be done and the accomplishments that could be made.

When you look at the speed or the rapidity with which companies embraced energy conservation programs, you conclude that it was probably a function of how energy intensive they were rather than managerial awareness of the problem.

If you have a corporation that spends, as mine does, almost $900 million a year on conversion energy, you are pretty cognizant of the price increases that take place—and these increases provided a tremendous incentive. It is an economic imperative to use energy more efficiently.

I categorize what we do, into four different areas. The first is housekeeping, and I would like to call it the modernization of our operating and maintenance procedures.

Let us turn off lights when they are not in use. Turn off equipment when it is not in use, fix steam leaks, put insulation on lines—all of these things are housekeeping. We have an entirely different look at it now that energy is more expensive. These things are easy to do. By and large, they have been done and they were cheap.

The next area commonly goes by the term retrofit. I like to think of it as the modernization of facilities that were built when energy was cheap and did not have the degree of energy efficiency built into them that we would do now.

We have done a great deal to retrofit. We have lots of facilities down in the gulf coast that were designed when natural gas cost 15 cents and 18 cents per thousand cubic feet. Now, when you are paying $3 per thousand cubic feet for natural gas, you cannot stand the kind of wastage that was economic in the past. There are lots of opportunities to retrofit existing facilities.

The next area is new capacity. Obviously, when we engineer facilities today, they are designed to use energy optimally over the life of the facility. As a rule-of-thumb, this means that the heat recovery and heat utilization facilities, will be designed for energy prices perhaps 8 years out from the current year. There is a tremendous amount of capital that goes into these new facilities.

The last area is the development of new processes that are inherently more energy-efficient. We fortunately have a very fine example of this. Union Carbide developed a process to make polyethylene that uses 25 percent as much energy per pound as the old conventional technology. This is being widely practiced and we license it. It is a good example of the kind of things that can be done.

How do we go about energy conservation?

Well, I like to think that all businesses and companies have always been impelled with a desire to reduce costs and to remain competitive. When I look back at what we used to do, we did save energy, and it was part of a general cost reduction effort.

When the Arab oil embargo came, the price of energy went up, and we began highlighting energy conservation as a very important cost-saving activity. A lot of what we did, and a lot of what the Government did—that is, the Industrial Programs Office and DOE and its predecessors—was to help people recognize that there had been a significant change in the world of energy prices, and consequently there were new opportunities for conservation. It was imperative to organize programs which focused on energy saving, to develop scorekeeping, and to provide motivational materials.

The basic incentive for saving energy is cost reduction; it is not new.

Sometime ago, I said that my goal was to phase myself out of a job, because you don't accomplish energy conservation from a corporate department. It has to work through the line organization of every division and every plant in your organization—and they have to be motivated for it. If you get them to understand energy conservation—the scorekeeping and the fundamentals—they should be able to take it over and do it.

In the last 2 years, I have spent almost no time on energy conservation. We have the system in place.

You can have a system in place, but the problem is fighting for priority. There are so many things required for running a business these days that all seem to be the No. 1 priority. It is a matter of fighting to keep conservation up there.

In terms of some Government activities, I commented that the Department of Energy had been very helpful to industry as a whole in organizing programs and providing communications material.

I think that phase is behind us. The scorekeeping that was instituted originally on a voluntary basis with 6 industries, by law went to 10 industries, and finally to 20, and I think that it has been a very successful thing. It forced a lot of companies to organize programs, because they had to report. Once they started reporting, it motivated a lot of managers to emphasize energy conservation.

Scorekeeping is very important to management control and to evaluate companies' programs, but reporting to the Government has no value except, perhaps, for statistical purposes.

I would like to move into the area of retrofit.

I find that I have more salesmen calling me up wanting to see me than I could accommodate if I worked 24 hours a day.

There seems to be no lack of inventiveness, ingenuity, marketability on the part of business in supplying different kinds of heat exchangers, more efficient motors, or new computer control systems.

This is what business and industry does, and I think, by and large, they have done a good job.

We find that when a market can be identified and appears large enough, somebody will step in for the business opportunity and supply the kinds of things that we need.

In this activity, I think the vendors are the people who can assess the market most realistically—to pinpoint the applications and the economics of those applications—because they are putting their money on the line for manufacturing and mounting a sales effort. It is a lot easier and more cost effective for them to do it.

We strongly support a role for the Government in basic R&D, because this is something that business and industry, by and large, do not adequately support and fund.

We used to do a lot more of it, but we used to be a lot more profitable than we are now.

The thing that business and industry does well is to translate theory into practice, and in many areas we are held up because we need more theory. We need more understanding of the basics, and from there you can carry it into energy-saving processes and equipment.

I certainly would like to second the comments that have been made earlier about the difficulty of discontinuing research and development efforts.

We had a discussion at lunch about this, and I think I would like to put it this way: people who are good problem-solvers or good inventors are highly motivated to do that, and they don't give up easily. Somebody has to tell them to stop.

If business has their own money in this, there will be a lot more motivation to stop and to kill it.

I would like to end up with a statement about what the Government can do, or what the Government should do, to help industry improve its energy use efficiency.

Our biggest problem is really capital. My company, and companies in the chemical industry and other industries with whom I have talked, all say the same thing.

They have many projects that have been studied and evaluated, show good economic returns, but can't fund because of capital problems.

In fact, it sometimes makes you cry at the opportunities that are not being implemented.

I think that this is a general problem for the Government—to what degree is it vital or necessary to the nation to improve industrial energy use efficiency?

This gets into things such as our future dependence on imported oil. What impact does it have on the balance of payments? On inflation? And on national security?

The money that is available for energy conservation in industry is a function of profits more than anything. We have accelerated depreciation, and some tax credits, but a 10-percent energy tax credit does not provide an adequate incentive.

If it is a national policy to stimulate, to provide incentives for industrial conservation, it takes something like a 20-percent credit, as has been proposed in Congressman Heftel and Senator Wallop's bills.

The very limited 10-percent tax credit that we have had so far does not get people's attention. It has been pointed out that the capital that goes into saving energy is much less than the capital that goes into producing indigenous gas or oil. From a capital point of view, and on the basis of paybacks, it is to the nation's advantage to stimulate conservation rather than production of gas or oil.

It has also been pointed out that the government provides about seven times the dollar incentive for producing oil and gas as it does for conservation. It seems like we have a real imbalance between supply and demand there.

Lastly, I strongly recommend the immediate and complete decontrol of natural gas prices, because, once again, economics is the incentive, the motivator, not just for industry, but for all sectors of the economy. As long as people are seeing artifically low prices for some forms of energy, there is not a strong incentive to conserve energy.

Thank you.

Mr. **Sissine**. Thank you, Bruce.

Our next speaker will be Marc Ross. Marc was trained as a physicist. He worked on the theory of fundamental particles until 1970, and his work since then has included a focus on energy policy. Marc currently works as a professor of physics at the University of Michigan, and also is consultant to the Alliance to Save Energy. He has recently coauthored a book titled "Our Energy: Regaining Control."

[A biographical sketch of Dr. Ross follows:]

Dr. Marc H. Ross

Marc H. Ross is Professor of Physics at the University of Michigan. He worked on the theory of fundamental particles until 1970, when his interests shifted to energy and environmental problems. Dr. Ross directed the American Physical Society's study of efficient energy use in 1974. His research concerns the technology and economics of energy use. Dr. Ross' major activity at present is consultant to the MacArthur Industrial Incentives Project of the Alliance to Save Energy. His book on energy policy, "Our Energy: Regaining Control," coauthored with Robert H. Williams, was recently published by McGraw-Hill.

STATEMENT OF DR. MARC H. ROSS

Dr. Ross. I am very glad for that plug for our book.

I wrote the book with Bob Williams from Princeton. It is a good source on the things I am going to talk about.

I would like to talk about two areas of policymaking. One is investment in existing technology, and the other is creation of new technology. Of course, whether we like it or not, the Federal Government has all kinds of roles in both of these areas.

In the area of investment in existing technology, I want to discuss three public policy subcategories: capital—the most important, energy prices, and fostering management attention.

Under new technology, I will look at R&D, prototype development or demonstration and technical manpower training.

Let me start by asking: Why should the United States, as a nation, be interested in encouraging industrial energy efficiency rather than just leaving it—if that were possible—to the companies?

I want to show one transparency which is only a partial answer. It is an idea which is in the Annual Report to Congress by the Energy Information Administration. I took the same data and replotted it a little bit.

The transparency shows the percent price change, during half-year periods, for imported oil. It also shows that there have been a couple of points in the 1974 to 1982 period when the price actually fell 10 percent. Additionally, we see that whole period during the early period of the Iranian revolution where the price was going up very rapidly.

The other quantity which is plotted, the dashed curve, is the capacity utilization in the OPEC countries; that is, the ratio of the actual oil production level to the maximum production level they could sustain.

The record indicates that when the OPEC countries were producing at about 80 percent of their capacity, the oil price was stable. When the production was lower than that, they reduced their prices; there are at least two periods when this phenomenon occurred. And when the production was higher than that, they raised their prices.

These are deflated prices using the GNP deflator.

The most interesting thing about the OPEC price trend is the decline during 1980-81—the price decline which occurred largely because the U.S. demand for oil decreased.

The U.S. decline in oil demand during the past 3 years has meant a 10 percent decline in the utilization of OPEC's capacity to produce oil. Other countries have also contributed to the decline of oil production by OPEC countries.

So OPEC has not really been a monopoly. Each individual country discovers that in order to sell their oil and meet various kinds of obligations, it pays to reduce their prices.

A question that merits study is: How much control might the United States exercise over the price of oil?

We could exercise control by vigorously pursuing conservation.

The Nation would benefit by taking away some of those rents which are being paid to OPEC countries. I would not want to take it all away.

Let me go on to the policy programs relating to industrial energy conservation.

In the area of capital we have to begin with tax credits, loans, and grants. I would like to mention, with respect to loans and grants, that a group of us worked out a proposal which the Congress might consider for subsidizing the scrapping of obsolete, inefficient facilities, and the construction of new ones in the energy-intensive industries—much as one might propose to scrap energy-inefficient old cars in favor of new ones.

That proposal is contained in the Solar Energy Research Institute study titled "Building A Sustainable Future" that was published early last year by the House Committee on Energy and Commerce.

We might, on the other hand, reduce the Federal intervention in capital markets. That intervention, as has been mentioned, is not only in the general Federal borrowing; it is also in the Federal capital subsidies—the loans, tax credits, and other benefits divested especially toward the real estate industry and the energy industry.

I have a couple of transparencies which have to do with how much capital goes into the energy industry. The first shows the percentage of all business capital which is spent by the energy-producing industry. Of all business capital including—under a new definition—all the commercial buildings, energy's share is approaching 40 percent.

The electric utilities are said to have a hard time raising capital, but partly that is because they spend such a large part of the available capital. The following slide shows two evaluations of tax expenditures, how much the Federal Government subsidizes this capital spending by publicly owned electric utilities, privately owned utilities, and oil and gas companies. I have some copies of these slides, if people are interested.

Policies to reduce these subsidies should be considered. Federal intervention in capital markets is so pervasive, I believe, that the energy-intensive industries are being denied access to capital at reasonable rates.

More important than any of these policies—such as the introduction of special subsidies or the reduction of capital subsidies to competing areas—would be to help the energy-intensive firms to improve their profits. I don't really know how to do that any better than anyone else.

Energy pricing policies are next. Deregulation of gas prices, a move toward rationalization of electricity prices and energy taxes are things which people are considering. I will not take the time to discuss these in detail. Under management attention, I would like to echo the fact that we already did something interesting, which cost very little and was relatively effective. That was the energy-efficiency reporting program. I have I visited a number of companies, and several say they now have in place an effective procedure for defining their energy use per unit of production.

In some companies, energy people say it would have been harder to get management attention on this issue without the energy-efficiency reporting program.

This was not a costly program. In fact, a lot of programs that would be helpful, such as reducing capital subsidies in certain areas, deregulating gas prices, and information programs are not costly programs.

Incidentially, we should never return to the idea of mandatory fuel conversion programs or efficiency standards for things like motors and secondary materials. These are not effective ideas. I was glad to hear that such a path is not being chosen by the more energy-efficient countries of Europe and Japan.

I would like to spend a little time talking about research and development. We are encouraging more private R&D. But the fact is that, as Bruce Burns just mentioned, most companies are not going to do the more fundamental R&D. There is a very clear pattern that fundamental R&D is done in the private sector only when a firm sees that it has a good chance of capturing the results. In businesses where a single firm dominates, you often see a lot of basic R&D being done. In many industries, fundamental research is not done at all—so the United States is losing out in these areas.

I think this fact is very important. There is a lack of fundamental research, and it is associated with an attitude of many industries in this country that radical process change is unimportant.

In these industries, people believe that the only issue is capital. In contrast, when you talk to a firm which is involved in fundamental R&D—such as those of the chemical industry—then you find that people are interested in radical process change, and in technical issues as well as in capital. I think there is a need for the Federal Government to play a role in R&D for industries like paper, steel and cement.

We need to explore how that can be done effectively so that the academics don't run off and waste the money talking to themselves, for which there is a certain tendency.

For example, I think the use of industry-wide laboratories, and the involvement of trade associations and engineering societies in defining research programs would be effective mechanisms for research management. There are a number of possibilities for making an R&D program applicable to industry's needs.

I have a fourth transparency. This is a table from our book, compiled from data of the National Science Foundation, on the functions of Federal R&D moneys, on a percentage basis.

We looked at the category called Energy for Conversion and Development, and found that it was not directly related to industrial productivity. We made a similar finding for the category "Science and Technology base. They do have a category titled "Economic Growth and Productivity," which is third from the last, receiving 0.4 percent of the support. We found very different patterns of Government R&D support in other countries.

I have one other comment. We have had a program in the United States, the Office of Industrial Programs in the Department of Energy, which has been involved in industrial process R&D to some extent—primarily in joint ventures in prototypes for new energy-intensive manufacturing processes. This group was, I think, really learning its business; it was really becoming quite effective.

Just as university groups develop expertise and start to know their business, the same holds for bureaucratic groups. If those groups don't have some continuity, we lose a very important asset—it is not just the R&D dollars; it is also the know-how that goes with in managing a program like the one we may be losing. I think that is extraordinarily unfortunate.

So I certainly would recommend that R&D in the area of manufacturing processes is an important item for Congress to give more careful thought.

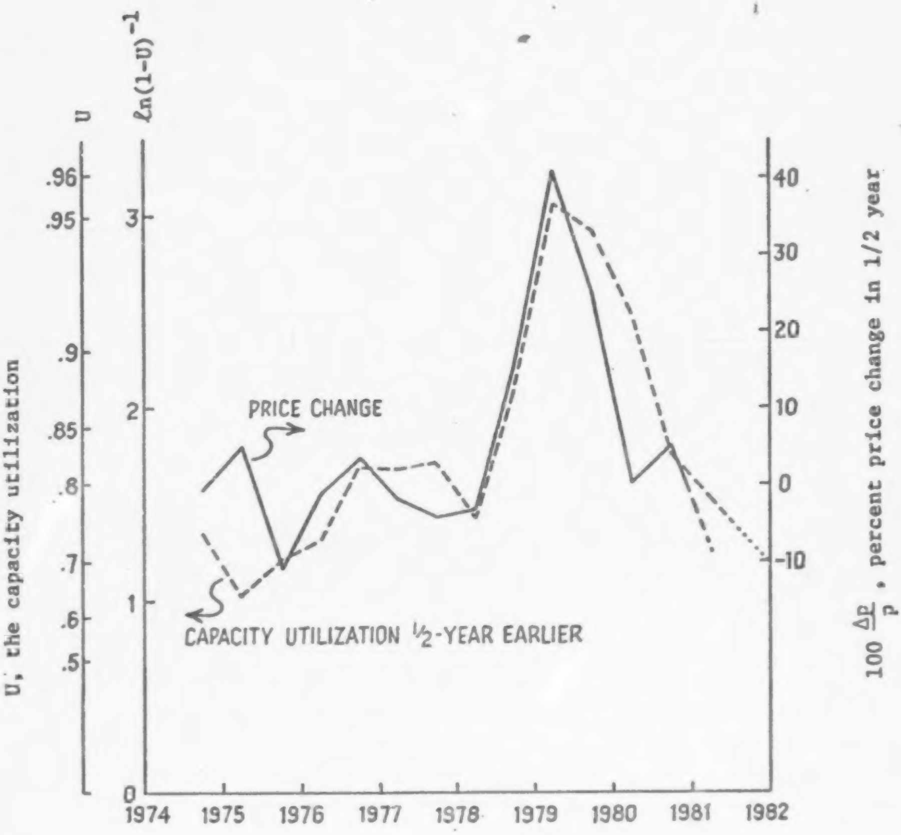
Finally, I will mention technical manpower training programs. My own view is that a lot of activity on the part of technical people will flow into this area if there is research money. Right now, people are very excited about computers and biotechnology. That is largely because of all the money which is present at the research level. Lots of people are very excited about it. These people fan out into industrial positions. They also fan out into other kinds of positions. They form a future constituency which is going to continue all that excitement and that further work in computers and biotechnology.

We need something similar in basic industrial processes. There is plenty of potential excitement there. I don't accept the notion that industrial process energy conservation is a dull subject. Computers are said to be an exciting subject. I find computers boring, as a matter of fact. It is not intrinsic that industrial processes be dull; it is only this way because we are not making the investment in young people who can carry the message, who would become excited. So I think it is very important that where private industry cannot carry the burden in research on industrial processes, the Federal Government should do so. It would not be expensive. It would have all kinds of ramifications which should not be measured by the immediate implementation of this or that device.

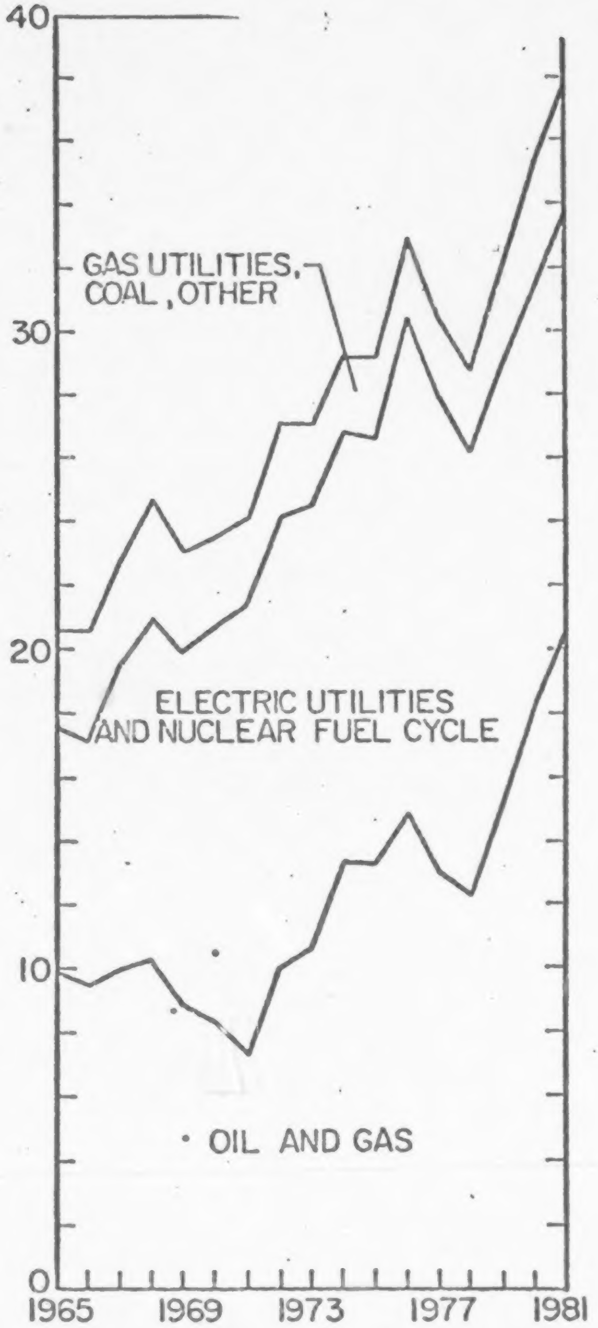
Thank you.

[Charts mentioned in the oral statement of Dr. Ross follow:]

Semi-Annual Change in Refiner's Acquisition Cost for Imported Crude Oil and OPEC Capacity Utilization (ex Iran)



Marc Ross
Physics Department
University of Michigan
1/82



PERCENTAGE OF NEW PLANT AND EQUIPMENT EXPENDITURES COMMITTED TO ENERGY SUPPLY

The following table is obtained from Office of Management and Budget, "Special Analysis G: Tax Expenditures", Reprint of Pages 203 through 238 from Special Analyses, Budget of the United States Government, 1982, January 1981.

Table G-3. HOUSING AND ENERGY TAX EXPENDITURES AND BUDGET OUTLAYS

(In millions of dollars)

Description	Fiscal year 1980	1981	1982
Housing:			
Owner-occupied housing:			
Tax expenditures (outlay equivalent)	26,840	33,170	41,655
Outlays	115	150	310
Total	26,955	33,320	41,965
Tax expenditures as a percent of total	99.6	99.6	99.3
Rental housing:			
Tax expenditures (outlay equivalent)	1,965	2,155	2,410
Outlays	6,025	7,280	8,680
Total	7,990	9,435	11,090
Tax expenditures as a percent of total	24.6	22.8	21.7
Total:			
Tax expenditures (outlay equivalent)	28,805	35,325	44,065
Outlays	6,140	7,430	8,990
Total	34,945	42,755	53,055
Tax expenditures as a percent of total	82.4	82.6	83.1
Energy:			
Conservation:			
Tax expenditures (outlay equivalent)	720	825	895
Outlays	570	750	1,065
Total	1,290	1,575	1,960
Tax expenditures as a percent of total	55.9	52.3	45.7
Supply:			
Tax expenditures (outlay equivalent)	7,715	9,520	10,875
Outlays	4,575	5,725	6,235
Total	12,290	15,245	17,110
Tax expenditures as a percent of total	62.8	62.4	63.6
Total:			
Tax expenditures (outlay equivalent)	8,435	10,345	11,770
Outlays	5,140	6,480	7,300
Total	13,575	16,825	19,070
Tax expenditures as a percent of total	62.1	61.5	61.7

*$5 million or less. All estimates have been rounded to the nearest $5 million.

Note: Details may not add to totals due to rounding.

Table 2.11 ESTIMATED FEDERAL GOVERNMENT SUBSIDIES IN SUPPORT OF THE ROUTINE PROVISION OF ENERGY SUPPLIES IN 1977

	(million 1977 dollars)
Federal Activities	
Low interest appropriations plus tax exemptions for hydroelectric and transmission facilities[a]	290
Enrichment services[b,c]	180
NRC regulatory costs[b]	146
Privately Owned Utilities	
Liberalized Depreciation[a,b]	2000 (approx)
Publically-Owned Utilities	
Exemption from federal income taxes[a]	
Tennessee Valley Authority	130
State power authorities and municipal utilities	80
Rural Electrification Administration (REA)	294
Tax exempt bond subsidies[a]	260
Loans and loan guarantees provided by REA	260
Oil and Gas Industries	
Percentage depletion allowance[a]	
Oil	550
Gas	1150
Expensing of intangible exploration and development costs	
Oil	740
Gas	460
TOTAL	6540

Notes:

(a) B.W. Cone et al., (An Analysis of Federal Incentives Used to Stimulate Energy Production), second revised report prepared by Battelle Pacific Northwest laboratory, PNL-2410 Rev. I, February 1980.

(b) General Accounting Office, "Nuclear Power Costs and Subsidies," June 13, 1979.

(c) The subsidy for enrichment services is the estimated difference between what the private sector would have charged and what the government actually charged.

(d) The liberalized depreciation allowance for utilities translates into an outright tax savings (instead of just a deferral) for a utility growing sufficiently rapidly or for a utility that is not growing, as long as there is significant general inflation.

Source: Robert H. Williams, Princeton University
Testimony before the Energy Conservation and Power Subcommittee, U.S. House of Representatives, February 26, 1981.

14.12b

Table 14.2. Federal Research and Development funds, function, for fiscal year 1978. Percent.

National Defense	49.0
Space	11.9
Energy conversion and development	10.6
Health	10.2
Environment	4.2
Science and technology base	4.0
Transportation and communication	3.1
Natural Resources	2.3
Food, fibre, other agriculture	1.9
Education	1.0
Income security, social services	0.6
Area and community development	0.4
Economic growth and productivity	0.4
International development	0.3
Crime	0.2

Source: National Science Foundation, "Fiscal Years 1969-1978, Analysis of Federal R&D Funding by Function," NSF77-326, 1977.

Mr. SISSINE. Thank you, Marc.

Our next speaker will be Ed Sherry. Ed's training was in chemical engineering. He organized the industrial energy group, a voice for industrial groups, and helped to form Elcon, the Electricity Consumers Resource Council. Ed has recently been involved with publications on coal policy and the hard-versus-soft energy path. He is currently director of energy supply for Air Products & Chemicals Corp. Ed?

[A biographical sketch of Mr. Sherry follows:]

EDWARD V. SHERRY

Age 50, married, 4 children.

Home: 1031 North 7th Street, Emmaus, PA 18049.

Position: Director of Energy Supply, Air Products and Chemicals, Inc., P.O. Box 538, Allentown, PA 18105.

Education: B.S. & M.S. Chemical Engineering Columbia University.

Mr. Sherry has been a leader in the organization of industrial energy users to influence national energy policy. In 1973, Mr. Sherry initiated the Industrial Energy Group which continues to be the core organization for the formation of special industrial users groups. Mr. Sherry was a participant in the formation of the Electricity Consumers Resource Council, Elcon, and served on its first executive committee. As a representative of industrial energy users on the plenary committee of the National Coal Policy Project, Mr. Sherry contributed to the Industrial-Environmental Consensus on Coal which was published as "Where We Agree." Mr. Sherry has served on several advisory committees to the FPC and FEA. Among many articles on energy, Mr. Sherry authored "Hard or Soft—Each to His Own Taste", a wide ranging review of the philosophical basis for the motivation of various energy groups.

STATEMENT OF EDWARD V. SHERRY

Mr. SHERRY. Thank you very much. Good afternoon, ladies and gentlemen.

It is a pleasure to be here in these beautiful surroundings, with such knowledgeable people, and beautiful violins. I guess I am the only person in Pennsylvania that now knows where the Stradivarius collection is housed in Washington. That may soon be more useful information than knowing where the energy information is housed in Washington.

The topic I was given is energy conservation. I gather that most of the discussion has been about research and development, and some of it has focused on the education of technical people and related items. These topics are different enough that I think our position on them would be different than our position on energy conservation, as I will extol here. As most of you know we espouse governmental aid for synthetic fuels development.

What we are talking about is a situation affecting the overall economy. The Government has only so much money. It can't do everything that is proposed. Among all these topics, energy conservation is the one which I prefer to talk about because I think our company and our industry has a lot to brag about in this area.

The chemical industry is a large consumer of all forms of energy for raw materials and for fuel. Its use accounts for 31 percent of all the energy used by all industry in the United States. Since oil and natural gas are of critical importance, the portion that the energy chemical industry uses is even more critical. It constitutes 8.1 percent of all the oil and natural gas consumed in the United States.

The chemical industry reports statistics to DOE through the Chemical Manufacturers Association, which represents 155 firms. Since 1972, the industry has improved its energy efficiency by 22 percent. As we discussed this morning, this figure is based on units of production. If your market is bad and your products are not selling at good prices, it could be a different number in terms of the ratio to your revenue dollars.

My own company, Air Products & Chemicals, is an integrated national company engaged in the supply of industrial gases and chemicals used by a wide variety of industries. Our sales are about $1.6 billion a year. Of this $1.6 billion, approximately 33 percent comes in one door and immediately goes out the other door to an energy supplier. That is, 33 cents out of each dollar of revenue is used to acquire energy. That is pretty extreme energy intensity.

Our direct energy purchases alone, not counting the energy content in the chemical raw materials we buy, amounts to 17 cents out of each sales dollar. In the industrial gas product line and in the production of oxygen and nitrogen, electric power is the main source of energy. It accounts for 50 percent of the product cost.

In fact, in certain specific plants, electric power represents over 70 percent of the cost of production.

Last year, our company spent $185 million for electricity purchases alone. Because of this energy intensity, efficient utilization of energy has always been critically important for our products; it affects every element in the entire organization.

Just because an Act of Congress has been passed, doesn't mean that someone can now come to our company and find a man whose job was created specifically by that act. However, if such a job does exist, that someone can say it is a good thing because now the company knows where its energy goes. Nevertheless, you would have found a similar situation had you talked to anybody in our company as much as 30 years ago.

In fact, our company was founded on a concept that would now be considered an energy conservation scheme. Our company exists because our founder established the idea of building oxygen and nitrogen generators onsite, rather than hauling the product around in very expensive, bulky steel tanks. This situation existed in large part before Air Products existed. It saves enormous amounts of energy.

A typical air separation plant is driven by electrical equipment. Electricity has always been the most expensive energy form. Since it is the only variable cost of production—in effect the raw material—these plants have always been designed for high efficiency.

This high efficiency was recognized by the DOE in 1975, when it established the standards for energy conservation for various industrial groups. In these standards, industrial gases were assigned a target of 9 percent efficiency improvement versus a 14-percent goal for the chemical industry, as a whole. In the last reporting year, Air Products increased its energy efficiency by 3 percent, and the cumulative improvement since the base year established by the DOE, 1972, is 17 percent.

Based on these figures, I think my firm and the whole chemical industry can be characterized as leaders in energy efficiency. Clearly, we have beat the targets by a wide margin. We are pleased by that result, but also very surprised. We are a mature industry; energy has always been a high cost item. Price increases, of course, have been a driving force; but when energy was 30 percent of costs, as it was back in the 1950's and 1960's, the additional improvement that you would expect by going from 30 percent of cost to 50 or 70 percent was marginal.

There are two factors that appear to have caused the good results that we obtained. First, now that practically everybody is striving for energy conservation, we find it is economical to buy energy-efficient equipment. Earlier, such equipment would have been specially ordered, specially designed devices which we would like to have had but were very expensive and probably unreliable.

Due to the nature of our products, the air separation industry always wanted to have energy-efficient compressors. This industry provided a base market for such compressors, thereby making it possible for other industries to buy energy-efficient compressors.

Now we are getting the same sort of event in reverse. Everybody wants energy efficiency. The base market has expanded tremendously, not only for efficient compressors, but for all sorts of other equipment which was not previously available. The effects are like a pyramid; we all benefit from the situation which created a market for these products.

The second big factor we found is the development of computer technology. We have put process-control computers on more than 40 plants, and we find they improve the efficiency tremendously. This improvement has been larger than we had anticipated, and a lot more than we had used to justify the investment for approval from the board.

You always make these numbers very high to justify the investment. They came out even better than expected.

I would like to argue that this improvement is a result of the accelerating development of technology and would have come to pass, energy crisis or no energy crisis. We would have bought those computers to control our plants even back when we were paying 6 mills per kilowatt-hour instead of the 3 cents we now pay, if they had been available at a reasonable price.

Now, of course, the relatively higher prices of energy have accelerated our program by giving an incrementally more rapid payback. But I think it is wrong when we credit all technological progress to the fact that we had an Arab oil embargo.

However, the problem with the economy is mitigating the improvements that we do have and is inhibiting further improvements. The higher energy prices have removed a lot of our cash flow. They also removed a lot of our potential market growth.

So, we are not building more efficient plants at as fast a rate as we would normally when expanding production. The point I am trying to make is that price is important, but we cannot attribute all improvements to it, and we have to look at the negative effect that high energy prices have on the economy.

Now, from that viewpoint, let's look at the role of Congress.

While I know there is not a complete agreement within the industrial sector, I think some of the industrial people in the room would not agree with me—Bruce Burns would not—but, in our opinion, there is real danger in providing explicit tax incentives for energy conservation. Conservation investments, like any other must compete with the capital available to the firm. Such an investment must be based on a wide variety of factors, including all the inherent risks in a project.

The value judgments made by different managements and different industries to decide on competing investments are much too complex to be written into laws and regulations. After all, there is only so much that can be achieved by law and regulation. I think almost everybody realizes now that we cannot substitute regulations for the infinite complexity of the market.

In addition, when we try to influence the market through nonprice incentives, we run into funding restraints. If we were to promote energy conservation tax credits and other things of that nature, we also reduce Government income. This, in turn, would mean less income available for the other programs people are talking about today, including R&D. We must must control the deficit and use revenue where it is most effective.

We would not oppose such legislation: nobody is going to look a gift horse in the mouth. We do, however, believe that much more can be gained by using equivalent funds for general tax relief to promote investment in new and more efficient production facilities rather than earmarking incentives for improving older plants and existing industries—as is bound to be the case when you target incentive legislation.

There are energy conservation projects before our own management that would be sped up and given more consideration if there were targeted tax incentives. There is no doubt that with such incentives additional conservation would be achieved. But I question whether it would be a better result than that which would be obtained if we used the same funds for an across-the-board reduction in taxes and improvement in the overall economy.

For example, one specific case I know quite well: We would replace all of the main processing equipment in one of our older plants with newer, more modern equipment, which is 20 percent more energy efficient—if we were able to get a slightly better return on investment than our current figures indicate. In order to qualify for the existing incentive—even if it were sufficiently increased—we would still have to accomplish this improvement on the site where the plant now exists.

However, our studies indicate that we would get a marginally better return on investment by locating the newer equipment on a brand new plant site in an entirely different State. A State where we could get a better, more favorable energy supply.

The net effect of such tax incentives, if they existed, would be to encourage improvement of the old site rather than development of the new site.

In evaluating the possible outcomes, of conservation incentives would likely promote older established industries—and we are one of those—when, as a nation, we might be better off to promote new and emerging industries.

We support the theme that Government action should be as neutral and permissive as possible, and that Congress can promote conservation best by repealing laws and regulations rather than passing new ones. The Administration has taken the position that the support for developing and implementing energy-efficient technologies resides with the private sector.

In order to dramatize this commitment on the part of the Administration, and as a means of recognizing the significant improvement that industry has made on its own, we recommend that Congress and the administration consider establishing energy efficiency awards to advertise what industry is already doing and has been doing on its own to improve energy efficiency and productivity.

In summary, we believe that industry can and is doing an effective job with conservation. This effort is a result driven not only by price, but also by competition and technology development. Government should be as neutral and permissive as possible to allow these market forces to operate.

Thank you.

Mr. SISSINE. Thank you very much. The variety of opinions seems to increase with each panelist, as it has all day.

Now, I would like to introduce our final panelist, Mr. Joe Tribble. Joe was trained primarily in the area of mechanical engineering. His work experience has taken him from Bethlehem Steel to Union Camp Corp., in the paper industry, where he recently worked as coordinator for energy management. Joe has been a leader of Georgia's Republican Party and is presently Assistant Secretary for Conservation and Renewable Energy at DOE.

Joe.

[A biographical sketch of Mr. Tribble follows:]

U.S. Department of Energy
Assistant Secretary for
Congressional, Intergovernmental
and Public Affairs
Office of Public Affairs
Washington, D.C. 20585
202/252-5644

BIOGRAPHY

JOSEPH J. TRIBBLE

Joseph J. Tribble was confirmed Assistant Secretary for Conservation and Renewable Energy, U.S. Department of Energy (DOE) on May 14, 1981.

Prior to his current appointment, Mr. Tribble was Energy Coordinator for the Unbleached Division of Union Camp Corporation. In that position, he was responsible for energy management for the firm's unbleached paper mills in Montgomery, Alabama; Monroe, Michigan; and in Savannah, Georgia. He previously held positions as assistant power plant superintendent and power plant superintendent, in the Savannah Mill which has the largest and most complex power plant in the industry and where several pioneering steps have been taken in energy utilization.

The primary objective of the Corporation's energy management program, to reduce the consumption of fossil fuels, has been achieved most notably at the Savannah plant, where fuel use per unit of production was reduced by 40 percent between 1972 and 1980. The overall success of the firm's energy management program has been attributed to a combination of measures, including increased use of energy-saving equipment, and increasing the amount of wood waste in the total fuel mix.

Mr. Tribble received a B.S. degree in mechanical engineering from Georgia Institute of Technology in 1942. From February 1942 to August 1943, he was with Bethlehem Steel Company, Bethlehem, Pennsylvania. He served with the U.S. Maritime Service from 1943 to 1946.

Mr. Tribble has been an active leader in the Republican Party since 1960, serving one term as State Chairman of the Republican Party of Georgia and two terms as State Senator (the first Republican State Senator from southeast Georgia in this century). He was a Delegate, Member of the Platform Committee, and Member of the Energy Subcommittee of the Republican National Conventions of 1976 and 1980. He was Chairman of the 1980 Reagan for President Campaign in the First Congressional District of Georgia.

A native of Forsyth, Georgia, Mr. Tribble is married to the former Laura Boddiford of Sylvania, Georgia. They have four children. At the time of his appointment he was serving as Chairman of the Administration Board of the Wesley Monumental United Methodist Church in Savannah.

May 1981

STATEMENT OF JOSEPH J. TRIBBLE

Mr. **Tribble**. When your name begins with a "T", you always sit in the back of the class. Now, I have found that you are also the last person on a panel. When you are the last speaker on the final of the three panels we have heard today, you are really in the clean-up position.

As other panelists have made comments, I have struck through many of my prepared comments, and now I find that there is little left which differs from preceding comments.

But maybe I can contrast a situation that we had several years ago with a situation that we feel we have now. Perhaps this contrast can give you some rationale for the policies that we think are appropriate. And I am afraid I must be redundant. From the time of the oil embargo in 1973 until 1980, the United States faced a problem which was quite different from any that we had faced before.

In this century, two world wars were won by the production capability of the United States. But now it appeared that our energy supply was being exhausted. We were becoming more and more dependent upon oil imported from the Middle East. Furthermore, the prices being charged for this oil were escalating rapidly and the production of oil and gas in the United States was declining.

Inexpensive energy, one of the basic building blocks of our economy, was becoming a thing of the past. We routinely spoke of the oil crisis. If we look at some of the causes of this crisis, perhaps we may know what to avoid in the future.

In 1954, a decision of the Supreme Court held that the Federal Power Commission should control the price of natural gas at the wellhead. Quite understandably, there was a difference of opinion between what the Federal Power Commission thought was a proper rate of return and what producers thought was a proper rate of return. There ensued a flurry of court cases to help determine what was a fair rate of return.

Prior to 1955, Saudi Arabia levied a royalty on oil that it produced and exported. For the oil companies importing this oil into the United States, this royalty was written off as a deduction for tax purposes.

In 1955, Saudi Arabia changed this royalty to a tax, which then became a tax credit for the oil companies rather than a deduction. Of course, there is a tremendous difference.

In the years prior to 1955, the number of oil wells being drilled in the United States was increasing rapidly. This number peaked in 1955, and, since that time, the decline has been almost as rapid as the previous increase.

Another factor was the Economic Stabilization Act of 1970, which put controls on the price of domestic oil. In 1972, the price of crude oil was on the order of $2 per barrel. The price of non-firm interstate natural gas was on the order of 35 cents per 1,000 cubic feet.

During the 7 years preceding 1973, virtually all of the growth in energy demand that took place in the United States came from oil and gas. Even though the next few years saw a doubling and quadrupling of the price of imported oil, the price of domestic oil continued to be controlled at unrealistically low prices.

Needless to say, there was little incentive during this period for the oil companies to produce oil in the United States.

This was also a period of time in which many people in and out of Government felt that Government actions could cure the disease. We had one national energy plan after another, Government regulation became more and more burdensome, and the building of nuclear powerplants came to a virtual standstill. Environmental controls adversely affected the efficiency of energy utilization. Energy conservation became the watchword. However, it was generally conceived to be doing without or making do with less rather than improving the efficiency of energy utilization. In the last half of the 1970's, legislation was passed and money appropriated for the encouraging the use of energy from renewable resources, and quite properly so.

Consequently, research, development, demonstration, and commercialization was begun in the fields of solar, geothermal, wind, biomass, and alcohol fuels. Several billions of dollars were spent, and the state of the art was advanced in all of these technologies. The solar industry was virtually forced into existence by virtue of the Federal Government being the major customer for its products.

There is no question that these expenditures did hasten the day that these alternative sources of energy would be viable.

Today, we have a different set of circumstances. Very shortly after President Reagan was inaugurated, he decontrolled the price of domestic oil. There has also been much discussion of accelerated deregulation of the price of natural gas.

As a result of these very clear market signals and also as a result of the conservation measures that have been taken in the last few years, the demand for energy is no longer increasing at the rates which we were once accustomed to. The importation of petroleum reached almost 9 million barrels per day in 1978. Now, the latest figures are on the order of 5 million barrels per day.

The price of this imported oil is no longer rising at the rapid rates that we have seen in past years. In fact, it has recently been reduced, and we have heard from the OPEC nations that they expect to maintain a stable price throughout 1982. There is even some speculation that production rates are such that it would be difficult for them to even maintain present prices.

We also now have the strategic petroleum reserve filled at a reasonable level.

This is not to say that we should no longer be concerned about energy. Certainly, we should. It does say, however, that the level of concern can be reduced. Consequently, it is entirely appropriate that the policies of the Federal Government with respect to energy can and should be reviewed and perhaps modified.

With respect to conservation, we believe that the free market will dictate which conservation measures are cost effective, and insure that they will be taken.

Look for a moment at the subject of today's meeting—industrial energy conservation. To repeat a number that has been stated today, the 10 most energy-intensive industries reduced energy consumption per unit of production on the order of 17.6 percent during the period from 1972–80. And this improvement is continuing.

I believe most of you in industry who have seen this reduction take place will agree that it is due to the fact that your cost of energy was increasing and you foresaw the likelihood of further increases. Cost was the motivation that produced the result, rather than the Government regulations that were brought about in the latter part of the 1970's.

The tax consequences of the Economic Recovery Act of 1981 create incentives for industry to install energy-efficient equipment. We believe that industry will consider these investments in the same light that they consider other investments. We also believe that industry will depend upon rate of return in order to evaluate a decision to put in energy-efficient equipment.

We therefore see no reason to continue to spend Federal dollars on demonstration and commercialization of energy conservation technologies. Rather, we think that Federal expenditures should be aimed at research of a long-range, high-risk nature—research that individual companies and groups of companies may not be able to do.

For example, many combustion processes are relatively inefficient. We are accustomed to the fact that the internal combustion engine generally produces carbon monoxide related pollution. We are continuing research, therefore, into combustion processes. Some of this work is quite sophisticated.

Through laser spectroscopy, we are able to look through a quartz cylinder head of an operating internal combustion engine and analyze the products of combustion as the fuel is burned in various sections of the cylinder. This helps us to know where the carbon monoxide is formed, which in turn helps us know where particulates are created. We think that this type of research will be beneficial not only to the automobile industry, but also to anyone wherever the effects of combustion are a problem.

Another problem involves research on ceramic parts for gas turbines.

The only way that we will be able to improve the efficiency of gas turbines appreciably is to go to ceramic parts for the high-temperature section. Considerable progress is being made. This is another one of the programs that we are, at this time, continuing.

In the field of photovoltaics, work is being done on the theory of photon conversion, so we can improve the combination of materials that will give us longer life and better efficiency of photovoltaic equipment.

We also recognize that the building industry is widely dispersed, and it is difficult for research to be done which will result in more energy-efficient buildings. Consequently, some of the work we are doing is aimed at determining what the most cost-effective retrofit measures are. We have a computer program which we are continuing to validate. If you input the design of a building, the output will give you your energy demand. Through the use of this tool, people in the building industry are able to develop more energy-efficient buildings.

During the late 1970's, hundreds of millions of dollars were spent on constructing hardware which demonstrated the feasibility of flat plate collectors, geothermal wells, central receivers, parabolic troughs, wind machines, and small hydro facilities. We are now in the process of trying to bring these experiments to a successful conclusion. We want to document the data that we can get from these experiments and make it available to the general public and for anyone who would like to use it.

In the process we hope to turn over the equipment that has been used, if it continues to be cost effective, to the contractor or to someone else who would be interested in taking it over. Thereby, we can answer one of the questions that has been raised today: How do you stop a Government program?

We want to terminate our relationship with these projects and turn them over to someone else so that if they can function on an economical basis someone else will keep them going. Meanwhile, we will be through with them.

This is a very brief summary of our current policies and some of our current programs. We can talk more about it in the question-and-answer session. If we can bring down the rate of inflation, stimulate investment, and bring down the interest rates, then money will be available for industry and others to make cost-effective investments in energy conservation material and in modernization of equipment. This is what the President's economic recovery plan is designed to do.

We really think it should have a fair chance.

Mr. SISSINE. Thank you very much, Joe.

At this time, we would like to open up the session for questions and answers. But before I do, I would like to mention that there are several panelists from earlier sessions that are still with us in the audience. I would again like to emphasize that we encourage questions from you.

Perhaps some of the other people in the audience may also wish to ask you a couple of questions if they did not have a chance to catch the earlier sessions.

Would somebody on the panel like to begin with comments on someone else's statements?

Mr. SHERRY. I have some things I want to say, but I don't want to take up the time if somebody in the audience wants to go first.

On the question of comparing the United States with Europe: The United States is, of course, enormous compared with any individual country in Europe. With each European country, you can bring in an industry that manufactures a certain product. You may have only one such company in any one country, so obviously you can talk to them without worrying about competitors. The competition is provided by companies in neighboring countries.

In Germany or France, you have the same situation. The Government and the company can work much closer together.

We talk about regulation being less encompassing in Europe—of course you don't have to regulate something if you own it. In France, there is Government-owned electricity. The British Government doesn't have to regulate its power system either; it owns the power system. Similarly, the State also owns the British steel industry.

When you look at Dovernment sponsorship and Government money spent on R&D in England, you are looking at money spent for a nationalized industry. In the United States, you can add back to the economy the financial output of the private steel industry. Thus, comparisons between the United States and Europe are extremely difficult to do. The numbers have to be handled with a lot of care.

Mr. **Bailly**. May I respond to your statement?

Mr. **Sherry**. That is what it is meant for.

Mr. **Bailly**. I agree entirely with you; that is why I did not do it. The figures I showed did not include the so-called quasi-public companies you mentioned. I have excluded those from the statistics. My presentation referred strictly to money spent by governments on industry programs. By industry program, I did not include electric generation. I also did not include, for instance, the whole British steel program, which has been initiated directly with the steel industry by the U.K. Government to improve the efficiency of the steel industry.

I have not included the millions of dollars spent by the German Government, for instance, on the "R&D program for iron and steel technology." This program is not included in the figures I presented.

The same holds for Japan: I did not include the research programs on ceramic gas turbines, which total $60 million. I tried to keep profiles comparable.

I agree with you it is always difficult to do international comparisons. You have to be careful to compare apples and apples. That is the logic on which I based my presentation.

Mr. **Tribble**. What would the figures look like if you factored in the effects of various tax credits and tax incentives in all of the countries?

Mr. **Bailly**. For one, it is fairly complex. Many of the countries have tax credits for energy investments. In general, such credits are worth about 7.5 percent of the investment. From what I recall about Germany, for instance, incentives are not given in the form of a tax credit; but in the form of a grant.

But you mentioned other strategies—accelerated depreciation for instance. All of these types of mechanisms exist; they are in place. But in some countries, depending on what you invest in, you can write off your equipment much faster than you can under the depreciaton provisions of the Economic Recovery Tax Act.

Mr. **Tribble**. In less than 5 years?

Mr. **Bailly**. Yes. In some cases, it takes only 1 year. You have to look at the whole spectrum of what is available. When you talk about fiscal incentives, I would say that most European countries and Japan compare favorably with the United States, even under the Economic Recovery Tax Act.

You can also talk about capital market types of programs. As I told the audience in my presentation—which unfortunately, was too brief to discuss many of these issues in detail—many countries provide low-interest loans. Our firm works with many small- and medium-sized companies in the United States, companies with assets of less than $1 billion. I don't know of any company which has access to low-interest loans for energy conservation or, for that matter, any other investment. I would not know where to go—the

Small Business Administration? It just doesn't compare with the pool of funds available in Germany or Japan.

You talk about incentives for—let's say—taking risks in R&D, conducting applied engineering, setting up a production line, or promoting a product which is energy-efficient. I don't know of any such program in the United States which compares to the programs which have been in place in Germany. Again, their program is directed toward the small- and medium-sized companies.

One of the concerns I have about the meeting today is the lack of small business representation. Otherwise, I am in total agreement with most of the companies here, when they say that Government is not needed. If you are a big company—we also work with some companies in the $30-billion range and above—you don't need any help from the Federal Government. What you want is to get the Government off your back.

If you can relate Dr. Ross' description here, the only area where they need help from the Federal Government is access to the capital market. It kills you to borrow money at 16 percent, whether you are a big guy or a little guy—it is too high. But if you talk about a small- and medium-sized company, it does not have the technical know-how to deal with this problem. We know; we work with them.

When you are a $200 million company, putting $5 million into an R&D type of project, it is a big chunk of money. And in the current economic situations they need it for the nondiscretionary type of investment that Mr. Harvey talked about this morning—just for maintenance capital. My concern is for the competitiveness of American industry, particularly small- and medium-sized companies, which are among the most innovative companies. When I am competing as a small $250 million company in a global market, I am in trouble. This is more and more the case in today's world, where I must compete against firms from Western Europe and Japan which are heavily subsidized by their government.

U.S. companies are being put at a competitive disadvantage. In other nations, you have somebody picking up your tab, and minimizing the risks of developing products. If you don't have the same situation in the United States, you are likely to be beaten out of this market ultimately. If you are a big company, the problem is less acute than it is for a small company.

Mr. SISSINE. Other questions?

Mr. HOFFMAN. Allen Hoffman. I would like to ask Mr. Bailly a question that was raised in an article from the Harvard Business Review.

It was a question of supply-side policies versus industrial policy. The basic question was: Do you form policies that try to stimulate general investment or do you develop more focused policies, such as the European countries have, toward particular industries?

We are probably approaching a debate on this issue. Europe is going one way, and they clearly have their governments helping certain industries in order to reduce social costs and disruptions.

In contrast, we are moving toward a policy of trying to stimulate general investment. It is a different kind of policy. Can you comment on the advantages and disadvantages of these two approaches for the United States?

Mr. **Bailly**. We could spend hours on this.

There is such a thing as competitive analysis in the private sector, which more and more U.S. companies do now.

Japan and the European governments apply the same techniques which are used in the private sector, like portfolio analysis, in order to develop strategies for pushing industrial development.

These governments see an opportunity to support industries which they feel we would then not be able to compete with. Some countries are dropping support for certain industries in the short term and pushing others which are focused on new technology.

That is the way the Europeans are approaching the problem, and that is the way the Japanese are approaching the problem. They are putting some of the highly energy-intensive industries offshore, and concentrating on the less energy-intensive industries like computers.

That is the most important comment I can make.

I believe that the Europeans have not yet proven whether they are wrong or right. You cannot foresee the possible results over a period of 2, 3, or 4 years.

I believe that the policies in the United States have been liberalizing the market. Freeing up the market and providing incentives to work is OK, and I think it should be given a chance.

However, I also believe that you cannot be so ideological that you go completely the other way, and refuse to recognize that in many sectors you operate in a global market. I insist on emphasizing this point. A policy of freeing the U.S. market of all restrictions and not providing incentive for certain companies—whether it is access to capital or other incentives—while other countries do provide them for their industries: That is like playing a poker game where each person has different rules.

In some of the sectors, foreign players have better sets of results than the U.S. players do. Ultimately, that can lead to loss of competitiveness which, in turn, can result in a loss of trade, loss of domestic market share, and so on and so on.

That is my concern.

Having been in this business for 13 years, one thing which bothers me a lot is that there was a time when the United States was really considered the leader, the technological leader. If it was U.S. engineering, my God, it was the best, and everybody wanted U.S. engineering firms abroad.

Well, we have been hired recently by the French Government to look at ways of improving the energy efficiency of their industrial processes. And the United States is not perceived as the leader in that area. Increasingly, nations turn to Japan and Germany, and France for help in drawing up the blueprints which outline how they should go into other industries. We should be careful about that, because when they consult with a French firm or a German firm, it is likely to prescribe French or German equipment and manufacturers. This means that the United States is losing an important advantage.

I discussed the same issue with some of our very big engineering constructors in Los Angeles. They are also concerned about this problem. This is what everything boils down to: The technology leadership is eroding, and has gone into a downward spiral to some extent.

We should not accept this erosion on the premise that: We are doing great with robots and computers; so what if our steel does not make it on its own?

It is a fallacy to think that industries like steel are unimportant to national economic well-being.

Mr. **Sissine**. Gene Frankel?

Dr. **Frankel**. I would like to ask a question about cost shared development and demonstration.

It seems to be a point of real polarization running through the discussion today.

Some people have said that it is a valid role for Government, that Government participation in cost sharing is needed to mitigate the risk in the demonstration of existing equipment, new applications of existing equipment, and the near-term development of efficiency equipment.

Others have said that cost-sharing is not a proper Federal role. But I don't hear any reason why it should not be a proper Federal role, other than arguments which I tend to think are based on pure ideology.

If there really is a risk of having a production line close down if you put in a brand new process you have never tried before, why is it wrong for the Government to share the risk with a private firm?

Why is that not a proper Federal role?

Mr. **Sherry**. If a process is uneconomic and the wrong thing to do, the economic system says don't do it. It is wrong to distort the system by causing that investment to happen anyway. If all the economics indicates that project doesn't have a proper return on investment and is not competitive, then it would be wrong for the Government to step in and say: Well, I think the economics should not be that way, people should like the results of this project. It should be economic on its own merit. Only then should the Government step in.

Dr. **Frankel**. I am talking about a situation where you have risk.

In other words, you are saying that if you know the economics are going to pay off, you will obviously do it. Suppose that the economics looks good, but there is a 60-percent risk of failure?

Mr. **Sherry**. The 60-percent risk of failure creates higher interest rates for the investment—and the economic system takes care of that.

I am not talking about research and development. Government support is needed for universities and university laboratories to keep producing technically trained people. This training just won't happen by market forces alone.

Long-term research and development on processes for synthetic fuels and things of that nature constitutes a proper role for Government. But when you go into an individual plant and say you know better how to run that plant, then we have a problem.

Mr. **Harvey**. The Government never does that.

Mr. **Sissine**. We will take one last question.

Mr. **Hahn**. Walter Hahn.

Many people in the information business assume that Federal dollars spent for R&D in an industrial firm constitutes a displacement of dollars.

However, it turns out that with some energy activities, the latest research shows that this is not quite true.

Edwin Mansfield was quoted here earlier, and I would like to quote from one of his recent studies:

> My own work, based on data obtained from a sample of 25 major firms in the chemical, oil, electrical equipment, and primary metals industries, focuses on the important area of energy.
>
> The results indicate that these firms would have financed only a small proportion of the energy R&D that they performed with Government support.
>
> If a ten percent increase were to occur in Federal funding for their energy R&D, the average response would have been that, for each dollar increase in Federal support, they would have increased their own support of energy R&D by about 6 cents per year for the first 2 years after the increase in Federal funds.
>
> These results are quite consistent with those obtained recently by Levin and Reiss, Levy and Terleckyj, and Scott in their statistical studies of the aggregate relationship between Federally funded R&D expenditures and privately funded R&D expenditures.
>
> For example, Levin and Reiss find that, on the average, a one-dollar increase in Government R&D spending leads to a 7-cent increase in company R&D spending. Since the data and methods used in these four studies were quite different, and the studies were carried out entirely independently—frequently without any knowledge of the other studies—the similarity of the findings is impressive.
>
> Of course, this does not mean that the available evidence is more than a small fraction of what needs to be known on this score.
>
> But, given the almost complete lack of solid information bearing on this important question, these findings, despite their limitations, seem worthy of serious consideration.

There seems to be a lot of evidence that the injection of Federal R&D actually stimulates private R&D and this observation has not been factored into a lot of the policymaking to date.

[The Mansfield paper follows:]

Effects of Federal Support on Privately Financed R and D

Edwin Mansfield

There long has been uncertainty and controversy concerning the effects of government R and D on private R and D. Based on detailed empirical studies carried out recently, the available evidence suggests that government R and D tends to be complementary to private R and D. My own work, based on data obtained from a sample of 25 major firms in the chemical, oil, electrical equipment, and primary metals industries, focuses on the important area of energy. The results indicate that these firms would have financed only a small proportion of the energy R and D that they performed with government support. If a 10 percent increase were to occur in federal funding for their energy R and D, the average response would have been that, for each dollar increase in federal support, they would have increased their own support of energy R and D by about 6 cents per year for the first two years after the increase in federal funds. 1/

These results are quite consistent with those obtained recently by Levin and Reiss, Levy and Terleckyj, and Scott in their statistical studies of the aggregate relationship between federally funded R and D expenditures and privately funded R and D expenditures. 2/ For example, Levin and Reiss find that, on the average, a one-dollar increase in government R and D spending leads to a 7-cent increase in company R and D spending. Since the data and methods used in these four studies were quite different, and the studies were carried out entirely independently (frequently without any knowledge of the other studies), the similarity of the findings is impressive. Of course, this does not mean that the available evidence is more than a small fraction of what needs to be known on this score. But given the almost complete lack of solid information bearing on this important question, these findings, despite their limitations, seem worthy of serious consideration.

1/ For further details and references, see Edwin Mansfield, "R and D and Innovation: Some Empirical Findings," Conference on R and D, Patents, and Productivity, National Bureau of Economic Research, October 2-4, 1981.

2/ See Richard Levin and Peter Reiss, "Tests of a Schumpeterean Model of R and D and Market Structure," and John Scott, "Firm Versus Industry Variability in R and D Intensity," ibid., as well as David Levy and Nestor Terleckyj, "Government-Financed R and D and Productivity Growth: Macroeconomic Evidence," unpublished paper, 1981.

Mr. **Sissine**. One more question?

Mr. **Ryan**. James Ryan. Mr. Burns and Mr. Sherry, could you give us some examples of projects or processes whose implementation would have been affected by a tax credit?

Mr. Sherry said there were some that might be affected by it, but he didn't agree that there should be some. Bruce, you indicated that there were some that would be affected by a 10-percent tax credit.

Mr. **Burns**. It is a situation where my company and a large number of companies in American industry—for many of the reasons that have been brought up or that one of the panels this morning brought up—do not have all of the capital to fund all of the economically viable projects. Thus, there have to be some forced decisions made as to which get funded and which do not.

From an energy conservation point of view, you might say this is deplorable, but it is a fact of life that cost reduction projects are more deferrable than many others. And in what we are fighting for is priority in the allocation of capital funds.

The 10-percent credit that has been available so far has been murky because it took the IRS so long to come up with rules. Then the rules were so restrictive that it has not been much of an incentive. In short, the 10-percent credit is a plus, but not a substantial plus.

However, a 20-percent energy tax credit is something that would catch people's attention.

With the credit at the 10-percent level, its effect is only a psychological phenomena. But we are looking at projects which have economic criteria that demand implementation without any tax credit. So the question is: What does it take to get funds allocated?

It will either take more capital or something to skew the way in which a corporation allocates capital.

Mr. **Ryan**. The credit does not affect the internal rate of return so much as it raises the level of debate, waves the flag, if you will, in promotion of energy conservation?

Mr. **Burns**. Yes, and one additional constraint also exists. Most of the proposals for energy tax credits have had a limited time that the credit would be available. Over a period of time we will implement conservation measures anyway, but if a tax credit is available for a 5-year period—and it is something significant like a 20-percent energy tax credit—it will provide a lot more incentive for management to make money available for such projects during the limited period of time.

Mr. **Sherry**. I have an example in mind. There are two ways we can improve efficiency for methanol production.

One way is to take a plant we already have, modify it extensively, and put a whole different tail-end process on it which makes it much more efficient. But, if we didn't have high interest rates and the economy were moving along with growth in the GNP, we would build a world scale, totally new methanol plant which would replace the old one. It would be located somewhere else, a brand new facility with much better equipment. In order to do this, we would need a bigger volume of demand; we would need growth in the economy.

So if you can get investment tax credits for free, and if they had no effect on the economy—interest rates, inflation, or the Federal deficit—of course, they are good. But if the credits tend to lower the rate of growth of GNP and depress the economy, they would not be acceptable. We would rather have the economy pick up, the overall economic situation is more important than any one sector.

The United States is a very complex industrial country. When you encounter European industry, you are dealing with a variety of different countries, each of which is characterized by a relatively narrow group of industries. None of these industrial sectors adds up to a $3 trillion economy like the United States. We need a neutral program helping all industry in general. The same result occurs if you divide the United States up into 50 States, with each State responsible for assisting its own industrial sector. The net effect of the 50 efforts should be to help everybody. What I'm saying is that since this country is so big, the problem is the overall economy, and that is basically the Administration's position.

Mr. RYAN. The tax credit encourages retrofit rather than new processes?

Mr. SHERRY. Our objection is that it costs money and that the money might be better spent lowering interest rates and lowering the overall take of Government out of the funds available to industry for other investments. This would be preferable to saying that it has to be targeted for energy conservation investments rather than something else.

Mr. SISSINE. With that comment, we will close this panel. Perhaps you can continue the questions afterward.

I would like to thank all our current panelists and all of those from earlier sessions very much on behalf of CRS and the House Science and Technology Committee. Thank you.

[Whereupon, at 4:05 p.m., the seminar was adjourned.]

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